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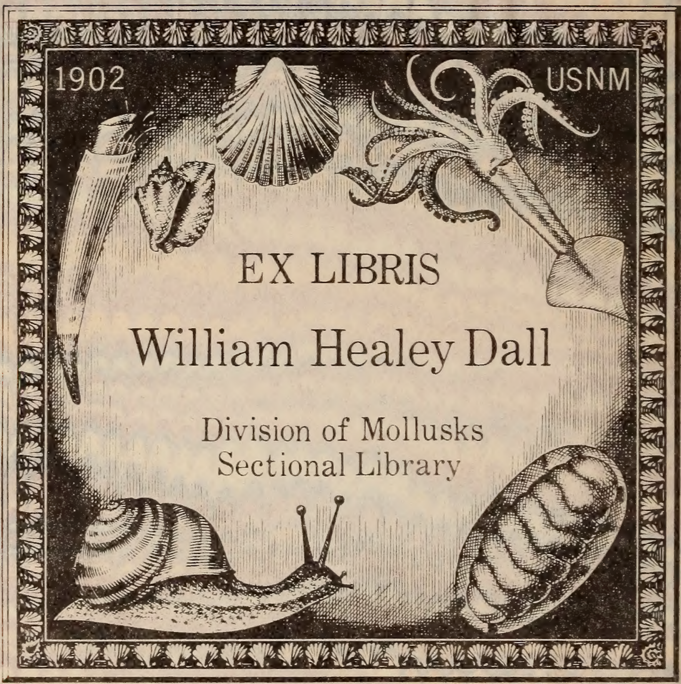

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PROCEEDINGS

OF THE

Boston Society of Natural History.

Division of Mollusks
Sectional Library

VOL. XX.

1878–1880.

Smithsonian Institution
National Museum

BOSTON:
PRINTED FOR THE SOCIETY.
1881.

PUBLISHING COMMITTEE.

S. H. Scudder,	Edward Burgess,
S. L. Abbot, M.D.,	F. W. Putnam,

Alpheus Hyatt.

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Sig. 3.	Jan. 22, 1879.	Sig. 19.	Dec. 17, 1879.
Sig. 4.	Feb. 5, 1879.	Sig. 20.	Feb. 5, 1880.
Sig. 5.	Feb. 5, 1879.	Sig. 21.	Apr. 7, 1880.
Sig. 6.	Mar. 1, 1879.	Sig. 22.	Apr. 7, 1880.
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Sig. 15.	Nov. 20, 1879.	Sig. 31.	Aug. 5, 1881.
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PROCEEDINGS

OF THE

Boston Society of Natural History.

VOL. XX.

PART I. MAY—NOVEMBER, 1878.

BOSTON:
PUBLISHED MARCH, 1879.

PROCEEDINGS

OF THE

BOSTON SOCIETY OF NATURAL HISTORY.

TAKEN FROM THE SOCIETY'S RECORDS.

Annual Meeting. May 1, 1878.

Vice-President, Mr. S. H. Scudder, in the chair. Twenty-four persons present.

The following reports were presented:

Report of Prof. Hyatt, Custodian.

The past official year has been even more uneventful than the last. The Council decided, in May, that no further improvement in the cases could be made, our funds not permitting any outlay beyond the necessary expenses of the year. This decision, though necessary, arrested our progress in a direction which would soon have rendered all the collections in the building secure from damage by dust or insects. The loss from this cause, if work is not speedily resumed, will amount to a considerable percentage of the work already done.

CONDITION OF THE COLLECTIONS.

The Minerals are in the same good condition as formerly and have, as usual, received valuable additions through the generosity of the President, Mr. Bouvé.

Mr. Crosby, Assistant in Paleontology, was obliged to remain absent for several months, and the details of the following final reports on sections of that collection had to be made up from the reports of Miss Carter and Miss Washburn, who had assisted him in the work of mounting and labelling.

The whole department is divided into sections according to locality. The North American fossils occupy the floor and wall cases of the south-east corner room of the main floor, and the wall cases on either side of the door of this room in the main hall. Opposite this is the European section in the north-east corner room on the same floor, and on either side of the door of that room. Between these, in the cases on the east side of the main hall and on the floor, are the small collections from South America, India, Australia, and Asia now possessed by the Society.

These collections are wholly devoted to the illustration of the stratigraphical relations of fossils. Each large formation is indicated by the color of the tablets upon which the specimens are mounted. Care has been taken to adopt a common nomenclature and a similar arrangement in each section. Thus the comparison of the fauna of one period in America with that of the same period in Europe is readily made and the differences and similarities studied to the best advantage. This advantage is obtained without the slightest sacrifice of clearness in the exposition of the relations in time of the various faunæ and floræ. It would be extremely hazardous to unite the European and American fossils of the same period in order to compare them as a whole with those of other periods. It is extremely doubtful whether the geological periods were really synchronous, and whether similarities in the fossils can be taken as proof of contemporaneous occurrence in widely separated localities. There can, however, be no doubt about the relation of succession in any one locality, and that the different faunæ and floræ of the great geological periods succeeded each other in similar order in each continental area. If therefore we adopt a common nomenclature according to the resemblances of the fossils, but keep the different continental areas separated, we express as nearly as possible the present state of knowledge with regard to the paleontological history of the earth.

The North American Collection, as reported upon by Miss Washburn, consists as follows: —

There are on exhibition,

	Genera.	*Species.*	*Specimens.*
Cambrian	109	208	626
Silurian	136	240	644
Devonian	207	371	1108
Sub-Carboniferous	95	205	570
Carboniferous	77	286	1072
Triassic	35	29	51
Jurassic	5	5	40
Cretaceous	83	154	658
Tertiary and recent	305	546	3066
	1040	2034	7834

These have been derived from the following sources,

From the Massachusetts Institute of Technology	2223
From various sources	3971
From the C. S. Hale Collection.	1013
From the Cleveland Collection.	627
	7834

The most valuable parts of this collection are the specimens of Paradoxides from Braintree, embracing the original of this species from the Jackson Cabinet; a fine suite of Crinoids from Mr. J. M. Barnard; the Coal plants of the Rogers' cabinet; the large track of the Brontozoon, and some fine slabs from Turner's Falls; the reptilian bones from the red sandstone of the Connecticut Valley from Prof. W. B. Rogers; the Attleboro' fossils, and the Tertiary fossils.

The New England collection of fossils occupies the floor cases, and is mounted in the same way, and is included in the above report on the North American collection.

The European Collection is almost wholly made up of the Eser Collection, which is reported upon by Miss Carter as follows:—

	Genera.	*Species.*	*Specimens.*
Cambrian	15	20	38
Silurian	15	17	27
Devonian	17	20	34
Sub-Carboniferous . .	12	19	16
Carboniferous . . .	21	46	120
Triassic	145	277	747
Jurassic	381	749	2164
Cretaceous . . .	181	260	608
Tertiary and recent . .	519	1258	5091
	1306	2663	8809

The valuable parts of this collection and its peculiar suitability for our purposes has been described fully in previous reports.

A very slight amount of work will finish the catalogue of the remaining collections, and a final report will be made next year upon the whole department.

The Botanical Department, under the charge of Mr. John Cummings, has been steadily progressing as in former years. The classification of Bentham and Hooker's "Genera Plantarum" has been adopted, and the revision of the Herbarium cannot be made ahead of the issue of the numbers of this book, which is still in course of publication. Three-fifths of all the flowering plants have been revised, and the work has been suspended until another part of the Genera Plantarum makes its appearance. Considerable progress has been made by Miss Carter in sorting over, condensing, and properly arranging the duplicates and filling out blanks in the general collection. Miss Carter has also sorted, mounted, and ticketed a large and valuable collection of Lichens under the direction of Mr. C. J. Sprague, who reports as follows:—

The Cryptogamous division of the Botanical department has been enriched by the discovery of a valuable collection of Lichens. This was formerly the Lichen-herbarium of Dr. Thomas Taylor, an Irish botanist, to whom Sir W. J. and Sir Joseph Hooker communicated the whole of their extensive collections of lichens, gathered during many exploring expeditions. Dr. Taylor published descriptions of these plants in the London Journal of Botany, 1844–46, and many of the specimens are the originals of the descriptions. In 1850 Mr. John A. Lowell purchased the collection from Dr. Taylor's heirs, and it formed a part of the herbarium subsequently presented by him to the Society. The knowledge of the structure of lichens has been greatly advanced since Dr. Taylor's day by the use of the microscope, and the nomenclature has undergone extensive changes. This herbarium, though consisting of over a thousand species, might have remained comparatively useless to the American student had it not been for the voluntary services of Prof. Edward T. Tuckerman. He has examined and named very nearly the entire collection, a work which no one else in this country could have done, and has given it an authentic value otherwise unattainable.

The work upon the Anatomical Collection has progressed to a point but little short of completion, and next year a final report will be made upon this department. A number of preparations have been added to this collection by the assistant, Mr. Van Vleck, and Dr. Thomas, a student in the Museum.

The Glen collection of microscopical slides, reported upon fully at the last annual meeting, has been catalogued and incorporated with our collections by Miss Washburn.

Mr. Van Vleck has revised the collection of Echinoderms, and we have received from the Museum of Comparative Zoology a suite of species of Ophiurians named by Mr. Theodore Lyman, which are of notable value on that account.

The decease of Dr. P. P. Carpenter of Montreal, in May, 1877, put an end to the work of naming the shells. Fortunately for us, however, he had nearly completed them. At the time of his death he had in his possession nearly one half of the Society's collection, and it was thought advisable for the Custodian to go to Montreal and superintend the removal of this valuable property. The shells were found to be in the most admirable condition; not one was lost or even out of place. The Custodian received very courteous treatment from Dr. Dawson, Principal of McGill College, where the collection was deposited. The thanks of the Society are also due to this gentleman for the trouble which he subsequently took in shipping the whole to the United States, a task rendered very difficult by our Custom House regulations. The entire lot, consisting of twenty boxes, containing 4000 tablets and ninety sets of duplicates, was received in excellent condition in October, and was unpacked and arranged by Mr. Van Vleck. The remounting and labelling with printed labels of the tablets has been completed, and the cataloguing nearly completed by Miss Washburn.

The systematic collection of Mollusca has been completed by Mr. Van Vleck, and is now on exhibition. It consists of 630 genera, represented by 2600 species and 9000 specimens. A final report upon the collection of Mollusca will be made during the coming year.

The Harris Collection of Coleoptera have been transferred to the new style of boxes, and the whole of this valuable typical collection is now safe from destruction by insects. Mr. Henshaw, who has worked upon the collection during the past year as in former years, reports as follows: —

The beetles have been arranged in families according to Dr. Le Conte's classification. The species have been identified only in those families which have been recently revised and monographed.

All the additions made during the year have been identified and incorporated in the main collection, and several advantageous exchanges effected. Valuable donations have been received from Messrs. Bryant, Smith, Thaxter, and Mrs. Möring.

A type collection for the use of the Laboratory has been begun and will be finished during the coming year.

The alcoholic collections of Reptiles and Batrachians have been in large part revised and named by Mr. Garman, of the Museum of Comparative Zoology, and returned to the Society. These have been catalogued and arranged on the shelves by Mr. Van Vleck, and a synoptical collection picked out. Considerable additions have been made to these collections by the kindness of Mr. Garman, by permission of Mr. Agassiz, who selected what was needed to fill gaps in our collection from the duplicates of the Museum of Comparative Zoology.

The Ornithological Collection has been under the charge of Dr. Brewer in great part, and therefore more progress has been made than in previous years. The collection of eggs has been revised and considerably increased by this gentleman. Through his exertions also the New England Collection of birds has been greatly enlarged by donations from various parties, and by exchanges. Eighty species have been added to our list, among them are some of great rarity, several being the typical evidences of the first recorded occurrence of the species in our fauna. The donors have been Messrs. Weeks, E. A. and O. Bangs, C. B. Cory, F. B. Loring, W. B. Greene, H. D. Morse, Wm. Brewster, Arthur Smith, Geo. A. Boardman, and H. O. Ryder.

LABORATORY.

The work in this department has greatly increased. The Educational collections, if they continue to be improved at the same rate, will, within a year or two, be entirely completed, with, of course, the exception of those rarer preparations and specimens which never seem to be within the reach of moderate means. They embrace typical zoological, paleontological, and geological collections, already sufficiently perfect for all the ordinary purposes of general instruction.

The room and these collections have been used this past year by the Institute of Technology for a class in Paleontology, by the Boston University for a class in Zoology and another in Geology, and by the Teachers of Boston for a class in Zoology. This last class is composed of the teachers of Natural History in the High Schools of Boston and other teachers, numbering about thirty in all.

The lessons are necessarily given on Saturday, and are limited to two hours, though the laboratory is open throughout the day for the use of those who wish to remain.

This course was instituted in order to support the movement made by the School Committee to introduce the teaching of Zoology into the High Schools. Miss Crocker, the Supervisor having this branch under her charge, applied to me for assistance, and by permission of the Council, the Laboratory and its facilities were placed at her disposal. The course will not be finished until the spring of 1879, and will comprise nearly one hundred lessons, illustrated in the usual way by the study and dissection of specimens. The instruction so far has consisted of a series of practical lessons given by Messrs. Crosby and Van Vleck, interspersed with lectures of a more general character delivered by the Custodian.

TEACHERS' SCHOOL OF SCIENCE.

This has been continued, as in former years, through the liberality of Mr. John Cummings. The course, consisting of twenty lectures upon the Principles of Systematic Botany, was given by Prof. Geo. L. Goodale, of Harvard University. Printed synopses of the lectures were placed in the hands of the teachers as aids in taking notes, and nearly all the large orders mentioned in the synopses were illustrated by specimens or diagrams. All the teachers were also provided with dried and named specimens of native plants suitable for private herbaria.

About one hundred and fifty sets of plants were distributed during the course, and much of the remaining material was consumed in practical exercises in analysis. The average attendance was greater than last year, being about 120.

Report of Mr. Burgess, Secretary.

The condition and year's work of the departments under the charge of the Secretary need little comment in addition to the statistics which follow. While these certainly show a satisfactory state of health and development, in many respects, it will be at the same time evident what should and could be done had we only the necessary means for its accomplishment.

LIBRARY.

The past annual reports have shown a regular increase in the use and consequent value of our library. During the past year 1066 volumes have been borrowed by 132 persons. These figures, of course, do not show the number of books used within the Library, nor the whole number of persons enjoying its privileges.

The growth of the Library is very constant; in the present case the number of additions amounts to 1656, a slight excess over the figures of last year. It should be remembered that a very large proportion of these additions is obtained through the exchange of our publications, and therefore includes only serial works, chiefly of similar Societies. For the purchase of other works, and the subscription cost of many journals, etc., which cannot be obtained by exchange, we must depend entirely on the Wolcott Fund income, amounting to less than $500,— a most inadequate sum for the purpose. Nine new exchanges have been arranged during the year, viz.: —

Kansas Academy of Science	Topeka.
Indian Museum	Calcutta.
Museo Civico di Storie Naturali di Genova	Genova.
Verein für Erdekunde	Halle.
Museo Nacional de México	México.
Ministerio de Fomento de la República Mexicana	México.
Linnean Society of New South Wales	Sydney.
Société d'Histoire Naturelle	Toulouse.
Wiener Obst- und Garten Zeitung	Wien.

Complete sets of the following journals have been purchased, which will be regularly subscribed to in future: —

Gegenbauer's Morphologischer Jahrbuch.
Selenke und Hoffmann's Niederland. Archiv für Zoologie.
His und Braune's Zeitsch. für Anatomie und Entwickelungsgeschichte.
Semper's Arbeiten aus der Zool.-zootom. Institut in Würzburg.
Cabanis' Journal für Ornithologie.

The Lloyd Republican Institution has been unable this season to place any popular works on our shelves.

The additions may be classified as follows: —

	8°.	4°.	Fol.	Total.
Volumes	201	52	2	255
Parts	758	173	34	966
Pamphlets	218	18		236
Maps and Charts				199
				1656

Owing to lack of funds no binding has been done.

PUBLICATIONS.

Two parts of the nineteenth volume of the Proceedings have been issued, and a third is nearly ready. This volume thus far contains nine plates, for seven of which, illustrating papers by the Rev. George T. Wright, and Col. Theodore Lyman, we are indebted to those gentlemen.

The second volume of the Memoirs has been concluded by the publication of a second part of Prof. Hyatt's "Revision of the Porifera," and a number including appendices to articles by Mr. S. H. Scudder and Baron Osten Sacken, together with an index, etc., to the whole volume.

MEETINGS.

Sixteen General Meetings, nine meetings of the Section of Entomology, and eleven of the Section of Botany have been held. The average attendance at the former has been forty persons, the largest number being ninety-six, and the least twenty-one. The attendance at the meetings of both sections has averaged about ten persons. Nearly forty papers read at these meetings have been published.

LECTURES.

Unfortunately public lectures have necessarily been given up the past winter.

MEMBERS.

Four Honorary, seven Corresponding, and twenty-two Associate Members have been elected during the year. The actual membership of the Society at present includes: —

Corporate and Associate Members	440
Patrons	91
Corresponding Members	232
Honorary Members	22

Report of Mr. Scudder, Treasurer.

ANNUAL STATEMENT OF RECEIPTS AND EXPENDITURES, MAY 1, 1878, BOSTON SOCIETY OF NATURAL HISTORY.

May 1, 1877, to May 1, 1878.

Admission Fees	$115.00
Annual Assessments	1395 00
Dividends and Income	4558.17
Walker Fund and Walker Prize Fund Income.	2233 15
" Grand Prize Fund Income	144.00
Bulfinch Street Estate Fund Income	1610.00
Courtis Fund Income	304.00
S. P. Pratt Fund Income	802.00
H. F. Wolcott Fund Income	576.00
Entomological Fund Income	20.00
John Cummings, Donation	638.63
Laboratory Students' Fees	422.00
	$12817.95

Excess of Receipts over Expenditures	$1336.73
Reserved in accordance with conditions of "Walker Bequest."	
Income from "General Fund," and Funds applicable to General purposes,	$9098.75
Expenditures for General Purposes.	8903.82
	$194.93

May 1, 1877, to May 1, 1878.

Library		$492.19
Cabinet	$2144.26	
Less fees for admission to Museum	123.62	
		2020.64
Publication and Printing	$1223.66	
Less receipts on this account	469.23	
		754.38
Laboratory		260.03
Lectures		638.63
Salaries		5820.00
Repairs of Building		264.17
Fuel		284.75
Gas		113.64
General Expenses		832.79
Balance		1336.73
		$12817.95

CHAS. W. SCUDDER,
Treasurer.

Boston, May 1, 1878.

We have examined the accounts of C. W. Scudder, Treasurer, and find them correctly cast and properly vouched. We have also examined and verified the evidences of property held by the Treasurer and by the Trustees of the "Walker Fund."

JOHN CUMMINGS,
R. C. GREENLEAF.

The reports were accepted. The meeting then proceeded to ballot for officers for the ensuing year. Messrs. Blake and Henshaw were requested to collect and count the ballots and declared the following gentlemen elected.

PRESIDENT,
THOMAS T. BOUVÉ.

VICE-PRESIDENTS,
SAMUEL H. SCUDDER, JOHN CUMMINGS.

CUSTODIAN,
ALPHEUS HYATT.

HONORARY SECRETARY,
S. L. ABBOT, M.D.

SECRETARY,
EDWARD BURGESS.

TREASURER,
CHARLES W. SCUDDER.

LIBRARIAN,
EDWARD BURGESS.

COMMITTEES ON DEPARTMENTS.

Minerals.

Thomas T. Bouvé,
L. S. Burbank,
R. H. Richards.

Geology.

L. S. Burbank,
T. Sterry Hunt,
Wm. H. Niles.

Palæontology.

Thos. T. Bouvé,
N. S. Shaler,

Botany.

John Cummings,
Charles J. Sprague,
J. Amory Lowell.

Microscopy.

Samuel Wells,
R. C. Greenleaf,
B. Joy Jeffries, M.D.

Comparative Anatomy.

Thomas Dwight, M.D.,
J. C. White, M.D.

Radiates, Crustaceans and Worms.

H. A. Hagen, M.D.,
Alexander Agassiz,
L. F de Pourtales.

Mollusks.

Edward S. Morse,
J. Henry Blake,
Levi L. Thaxter.

Insects.

S. H. Scudder,
Edward Burgess,
A. S. Packard, Jr., M.D.

Fishes and Reptiles.

F. W. Putnam,
Theodore Lyman,
S. W. Garman.

Birds.

Thomas M. Brewer, M.D.,
Samuel Cabot, M.D.,
J. A. Allen.

Mammals.

J. A. Allen,
J. B. S. Jackson, M.D.

Mr. Arthur F. Gray, of Danversport, was elected an Associate Member. Prof. Dr. Carl Semper of Würzburg, and Dr. C. C. Abbot of Trenton, N. J., were elected Corresponding Members.

The following resolution, offered by Mr. Chas. J. Sprague, was passed :

"That the thanks of the Society be conveyed to Prof. Edward Tuckerman for the voluntary, generous, and invaluable service he has rendered it by elaborating and naming the Lichen-herbarium of Dr. Thomas Taylor, now forming a part of its collections ; a service which no one in this country but he could have performed, and which gives to the herbarium an authentic value it could not otherwise have possessed."

The Custodian read a letter from Mr. Jona. Preston, the architect of the Museum, presenting a model and plans of the building.

The thanks of the Society were voted to Messrs. H. O. Ryder, H. A. Spencer, C. F. Rice, and F. J. C. Swift, for donations to the New England Collection of birds.

General Meeting. May 15, 1878.

The President, Mr. T. T. Bouvé, in the chair. Fifty-three persons present.

The following papers were read :

The Devonian Brachiopoda of the Province of Para, Brazil. By Richard Rathbun, late Assistant Geologist to the Geological Commission of Brazil, Professor Ch. Fred. Hartt, Chief.

The present paper is an abridgement of a report made to His Excellency, the Minister of Agriculture of Brazil, in 1877, and constitutes a complete list of the Devonian Brachiopods at present known from the Lower Amazonian Valley, with descriptions of several new species, and notes on those previously described. This report should properly follow the detailed account of the Devonian deposits of the Amazonas, which forms a chapter of considerable length in the first unpublished volume of the Geological Commission. The death of Professor Hartt has, however, delayed the publication of that work for a short time, and it has been deemed advisable to issue this report on the fossils at once. It thus becomes necessary to describe here in brief the localities where the species treated of in this paper were obtained, and the character and relations of the rocks in which they were found.

Prof. Hartt discovered on the Morgan Expedition in 1870 the interesting Devonian locality of Ereré, near Monte Alegre, on the Amazonas, where he procured the first Devonian fossils found east of the Andes in South America. In the following year he revisited Ereré, and made large additions to his former collections from there. This region he has fully described in the Bulletin of the Buffalo Society of Natural Science, for January, 1874 (pp. 201 to 235), and in the same publication (pp. 236–261) I have given descriptions of the Devonian Brachiopods obtained by him. In 1876, Mr. Orville A. Derby, of the Brazilian Commission, accompanied by Dr. F. José de Freitas and Mr. H. H. Smith of the same Commission, reëxamined the geology of Ereré, and traced the Devonian formation for some distance northward of that region, on the Rios Mæcurú and Curuá, finding on each of these two rivers richly fossiliferous sandstones. Passing northward from Ereré, the beds are crossed in descending order, so that the deposits of Ereré are newer in age than those of the Rios Mæcurú and Curuá.

The fossiliferous sandstones of the Rio Curuá appear to be identical with those on the Mæcurú, although the characters of the beds at the two places differ slightly; at the former locality they are fine in texture and hard, while at the latter place they are coarse and friable. At both of these localities, which are distant from one another about twenty-five miles, the fossils are confined to a limited series of beds. From the Mæcurú locality to the Ereré the distance is about seventy-five miles, the thickness of the intervening deposits, which are largely composed of beds of chert, being in the neighborhood of one hundred feet.

At Ereré only three additional species of Brachiopods were found; but on the Mæcurú and Curuá were discovered thirteen species new to the Brazilian Devonian fauna, of which three species are identical with New York State forms and the remainder, at least in part, new to science. The faunæ of the two series of deposits — the Ereré on the one hand, and the Mæcurú and Curuá on the other—are closely related, but I will leave the discussion of this subject for the close of the paper.

The collections of the Morgan Expeditions referred to in the following pages are contained in the Museum of Cornell University, Ithaca, New York; those of the Geological Commission of Brazil are at present deposited in the National Museum at Rio de Janeiro. Figures of many of the new species described in this paper were executed at Rio de Janeiro a year ago, and will probably be published in some future work of the Geological Commission.

Lingula spatulata (?) Hall.

Lingula spatulata Hall and Vanuxem, Geol. Repts., Third and Fourth Geol. Dists. N. Y., 1842 and '43; Hall, Palæont. of N. Y., IV, 13, 1867. *Lingula spatulata* (?) Rathbun, Bull. Buffalo Soc. Nat. Sci., I, no. 4, 258, fig. 1, 1874.

Only a single specimen of this species has been obtained from the Devonian of Brazil. Sandstone, Ereré, Prov. of Pará, Brazil. (Morgan Expedition, 1871.)

Lingula ererensis, sp. nov.

Shell of medium size, about two-thirds as wide as long, subelliptical in outline, and broadest near the middle; lateral margins nearly straight along the middle, but curving very slightly; anterior and posterior margins rounded, the former apparently the broader, and very regularly and strongly curved. Valves moderately convex, with a tendency to form a more or less defined median ridge near the beak. Surface marked with very fine, regular, closely-set concentric lines, which are only distinctly seen by the aid of a lense. In the interior of one valve exists a narrow V-shaped impression, having the point turned toward, and ending near, the beak. Length of the shell about 18 mm., breadth about 12 mm.

This species of Lingula is quite distinct from any of the other forms at Ereré. In outline it approaches *L. delia* Hall, of the Hamilton group of New York State, and like that species it has the fine concentric surface lines. The single specimen found is, however, too imperfect to permit of its relations to the above mentioned species being accurately determined.

Associated with *Spirifera Pedroana*, etc., in the Devonian sandstone of Ereré. (Geological Commission, 1876.)

Lingula Rodriguezii Rathbun.

Bull. Buffalo Soc. Nat. Sci., I, no. 4, p. 260, 1874.

Found, with *Discina lodensis*, in the Devonian shales of Ereré. (Morgan Ex., 1870.)

Lingula Stauntoniana Rathbun.

Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 259, fig. 3, 1874.

Moderately abundant in the Devonian shales of Ereré, associated with *Discina lodensis*, etc. (Morgan Ex., 1871; Geol. Comm., 1876.)

Lingula Gracana Rathbun.

Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 259, fig. 2, 1874.

Rare in the Devonian shales of Ereré, associated with *Discina lodensis*. (Morgan Ex., 1870; Geol. Comm., 1876.)

Discina lodensis Hall.

Orbicula lodensis Vanuxem, Geol. Rept. Third Dist. N. Y., p. 168, 1842; Hall, Geol. Rept. Fourth Dist. N. Y., p. 223, 1843. *Discina lodensis* Hall, Palæont. N. Y., IV, p. 22, 1867; Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 257, 1874. Compare *Discina media* Hall, Palæont. N. Y., IV, p. 20, 1867.

This species is very abundant in the dark shales of the Devonian of Ereré, and the collections obtained from there, represent it in its various stages of growth, from the very young to the adult shell. (Morgan Exs., 1870 and '71; Geol. Comm., 1876.)

Productella mæcuruensis, sp. nov.

Shell small and slightly asymmetrical in shape; length and breadth nearly equal, giving an irregularly subcircular outline to the shell, which is somewhat flattened posteriorly; hinge line straight and slightly shorter than the width of the shell; cardinal extremities not preserved in the single specimen obtained.

Ventral valve very convex (but rather less so than is usually the case in this genus), quite strongly curved from side to side, and strongly and nearly regularly curved from the beak to the front, the point of greatest prominence of the valve being, however, slightly posterior to the middle. Beak rather small, but strongly arched and regularly rounded, and projecting some distance behind the hinge line. The convexity of the umbo broadens with moderate rapidity forward, leaving the portions of the valve bordering the cardinal extremities slightly and irregularly flattened. The want of symmetry in the ventral valve results from the beak and more prominent line of curvature lying a little nearer the right margin than the left. Dorsal valve unknown.

The markings of the shell are indistinctly preserved in the single specimen I have examined; they appear to consist of short, low, rounded, radiating, raised lines, which are narrower than the intervening spaces. They are of variable lengths—one-eighth to one-sixth that of the valve, or more — and some appear to extend the entire length of the valve. They are more or less regularly distributed, and the anterior end of each line is slightly elevated, as though it had formed the base of a spine. The bases of two or three small spines are preserved near the right cardinal angle. Length and breadth of shell each about 9.5 mm.

Having only one specimen of this form, it is impossible to determine to what described species of Productella it may be the most closely related. The number of species of Productella described from the Devonian of North America is so large, that it is probable the form under discussion may ultimately fall into one of them. It bears a certain resemblance to several of Hall's species, more particularly *P. navicella* of the Corniferous limestone and Hamilton group of New York.

Devonian sandstone of the Rio Mæcurú, Pará. (Geol. Comm., 1876.)

Chonetes Comstockii Hartt, MS.[1]

Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 250, pl. IX, 1874.

Devonian sandstone, Ereré. (Morgan Exs., 1870 and '71; Geol. Comm., 1876.) Rio Mæcurú. (Geol. Comm., 1876.)

This species is of very common occurrence at Ereré, but only three small specimens were obtained from the Rio Mæcurú.

Chonetes Freitasii, sp. nov.

Shell usually quite strongly concavo-convex, and varying in outline from longitudinally semi-elliptical to transversely sub-elliptical or oblong; proportions of length to breadth as 6 to 7, 5 to 6, 3 to 4 or 2 to 3. Hinge line straight and, in the majority of cases, equalling the width of the shell or more. Cardinal extremities forming right or acute angles, and often much extended in sharp, mucronate points; but frequently the hinge line is shorter than the width of the shell, and the cardinal extremities are then obtusely angular or regularly rounded. Where the length of the hinge line equals the width of the shell, the lateral margins are straight and sub-parallel posteriorly, and anteriorly form, with the anterior margin, quite a regular semi-elliptical curve, or the anterior margin may be nearly straight along the middle. In other cases the curve of the margins from one cardinal angle to the other is quite regular, and subcircular or semi-elliptical.

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[1] By an oversight in the original paper on the Devonian Brachiopoda of Ereré (*loc. cit.*), I omitted to state that the names of the species therein accredited to Professor Hartt were taken from his manuscript notes.

Ventral valve generally very convex, and often gibbous or inflated; but at times much depressed. In specimens where the length and breadth of the shell are nearly equal, the valve is usually very regularly convex, and the curvature from side to side, and from the beak to the front, are subequal. The broader forms are frequently slightly, but broadly, flattened along the middle, along which there is often a shallow, undefined median depression of variable breadth, always beginning some distance anterior to the beak. At the cardinal extremities, and for some distance in front of them along the lateral margins, the valve is always flattened. In the larger specimens the width of the hinge area at the beak is from about 1 mm. to 1.5 mm.; at the cardinal angles it narrows down to about one-third its width at the beak. The beak is small and only slightly extended beyond the hinge margin. In the interior of the shell, there exists a thin, but distinct, median septum, equal to one-fifth or one-half the length of the valve, and sometimes quite heavy, but not elevated. Spines are indicated on a single specimen only. On this are preserved the bases of five spines, sub-equidistant from one another, and inclining outward at an angle of about fifty-five degrees.

Dorsal valve strongly concave, generally most concave near the middle, and having the curve from the beak to the anterior margin quite regular, but sometimes more rapid near the front. The cardinal angles are flattened, and along the middle there is frequently an undefined ridge, corresponding with the depression in the ventral valve. A few specimens show slight impressions of a medium sized cardinal process, but no septum occurs. The beginnings of the vascular impressions, directly in front of the cardinal process, and two short, slightly diverging ridges anterior to, and included between, the impressions are often preserved.

The raised lines of the shell are quite prominent, and slightly rounded or sub-angular on top; they are narrower than the intervening depressions, which are rounded in the bottom. The surface is often smooth at the cardinal extremities, and old shells are frequently much thickened along the hinge line. Four specimens of different shapes and sizes afford the following measurements, in connection with which are given the number of raised lines that mark the surface near the margin: (1) length 11 mm., breadth 13 mm., height 2.25 mm., raised lines thirty (absent from cardinal angles); (2) length 11.5 mm., width 14 mm., height 4 mm., raised lines forty; (3) length 13 mm., width 18 mm., height 3.5 mm., raised lines thirty-two (wanting on cardinal angles); (4) length 20 mm., width 29 mm., height 4.5 mm., raised lines forty-eight.

In this species we have included a number of forms, which might have served for the formation of several species were not the material in our possession so abundant as to afford a complete series of variations, uniting the different forms closely together. The younger shells are proportionately the narrower, and in after growth they increase more rapidly in width than in length. The younger forms are also frequently more convex in proportion to their size, than are the older, which often become broadly flattened or depressed along the middle. The older and broader forms are the more abundant ones. The smaller varieties of this species, having the length and breadth about equal, appear to represent *Chonetes deflecta* Hall, of the Hamilton group of New York State; the larger, more transverse forms, however, more closely resemble, at least in shape, some of the large species of Chonetes described by Prof. Hall from the Upper Helderberg group of New York. The nearest related one seems to be *C. acutiradiata* Hall.

This species of Chonetes is exceedingly abundant in the Devonian sandstone of the Rio Mæcurú, and the collection brought from there is very large, representing many varieties. A few specimens were also found on the Rio Curuá. The single ventral valve of a Chonetes described, but not named, in the Bull. Buff. Soc. Nat. Sci., Jan. '74, p. 253, very probably belongs to this species.

Rios Mæcurú and Curuá. (Geol. Comm. 1876.) Ereré. (?) (Morgan Ex., 1871.)

Chonetes Onettiana Rathbun.

Bull. Buff. Soc. Nat. Sci. I, no. 4, p. 253, pl. X., 1874.

Rare in the Devonian sandstone of Ereré. (Morgan Exs., 1870 and '71; Geol. Comm., 1876.)

Chonetes Herbert-Smithii Hartt, MS.

Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 251, pl. x, 1874.

An examination of the many specimens of Chonetes obtained at Ereré in 1876, proves a greater variation to exist among the forms referred to this species than was previously indicated, and it is probable that we have more than a single species included in *Chonetes Herbert-Smithii,* as originally founded. Much of the material at hand is in an imperfect state of preservation, the majority of the specimens, however, belonging to the type as first described. Thus it does not seem advisable to make a division of the species, until other and better material has been obtained.

Moderately abundant in the Devonian sandstone of Ereré. (Morgan Exs., 1870 and 71; Geol. Comm., 1876.)

Chonetes curuaensis, sp. nov.

Shell small and transverse, with the proportions of length to breadth about as 2 to 3; in outline longitudinally sub-semielliptical, the lateral margins being nearly straight posteriorly, and not curving much, excepting toward the front. Hinge line straight and nearly or quite as long as the width of the shell, which has the cardinal extremities forming right angles or, probably, slightly rounded.

Ventral valve gently convex and most elevated near the middle, but having the convexity slightly more pronounced on the umbonal region than toward the front of the valve. Curve along the transverse diameter gentle and nearly regular, though the sides of the valve appear to slope from the median line to the lateral margins with little curvature. Cardinal extremities flattened. Beak small, but distinctly marked, slightly depressed and projecting only a short distance behind the hinge line. There is a small, well-defined septum, extending forward from the beak a little more than one-fourth the shell length. Hinge area and spines not preserved. Surface marked with fine, but prominent, subangular, radiating raised lines, which are slightly narrower than the intervening depressions. There are about twenty-six of these lines on one ventral valve, on which, however, the cardinal extremities are smooth; there also exist one or two rather prominent, concentric lines of growth. Length of valve about 6 mm., breadth 9 mm. Dorsal valve unknown.

This species of Chonetes, which is represented by only a single perfect specimen, bears some resemblance to *C. Herbert-Smithii* of the Ereré locality, from which, however, it differs in the fact that the ventral valve of the former is less strongly convex, and has a more prominent beak and finer surface markings. It also resembles somewhat the young of *C. Freitasii* of the Rio Mæcurú locality. From *C. scitula* Hall, of the Hamilton group of New York State, which it resembles much in form, it differs in having fewer and coarser raised lines. Only a few specimens of this species have been found.

Devonian sandstone, Rio Curuá and doubtfully on the Mæcurú. (Geol. Comm., 1876.)

Chonetes, sp. indet.

There was obtained from the Devonian sandstone of the Rio Mæcurú a very small, smooth form of Chonetes, represented by only two specimens, which do not appear to belong to any of the species already described in this paper. The specimens are not, however, well enough preserved to permit of their being accurately determined.

Orthis Nettoana Rathbun.

Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 247, pl. x, 1874.

The finding of larger, more perfect specimens of this species in 1876 necessitates the following new description.

Shell small, with the valves subequally convex, or with the dorsal valve depressed and much less prominent than the ventral. Ventral valve subcircular or transversely subelliptical in outline; dorsal valve subelliptical. Greatest width of the shell near the middle; length of the hinge line equal to two-thirds the greatest width, or a little less; cardinal extremities rounded. Shell marked with radiating, raised lines.

Ventral valve quite convex and most prominent at, or just posterior to, the middle, whence the slope is very gentle toward the beak, but rather rapid toward the front. Surface of the valve curving regularly from side to side, or descending from the median line to the lateral margins with little curvature; curve from the beak to the front sometimes very regular. Cardinal extremities broadly and regularly rounded. In the broader forms the anterior margin is straightened along the front, or even slightly indented. Hinge area high, broadly triangular, with a broad triangular fissure, which sometimes occupies half of the area or more. Beak acute, but not extending beyond the line of the cardinal margins and scarcely incurving.

Dorsal valve moderately convex, sometimes depressed-convex, and generally with a broad, shallow, undefined median depression, which commences near the beak, and broadens rapidly toward the front, where its width equals one-third to one-half that of the valve. Beak depressed; hinge area narrow.

Dental lamellæ of the ventral valve, more or less separated at the beak, and extending forward, nearly parallel with one another, or diverging slightly. They are generally curved, their concave surfaces facing inwards. Distance between the lamellæ equal to about one-fifth or one-seventh the width of the valve; their length, one-fourth that of the valve, or slightly more. The socket plates of the dorsal valve extend in about the same direction, or diverge slightly more, but they are not as long as the lamellæ. Cardinal process not preserved.

Shell marked with fine, closely arranged, radiating raised lines, which are of about the same width as the depressions separating them, or slightly broader. They appear to increase in number mostly by intercalation. An elliptical specimen measures, length 15 mm., breadth 21 mm.; a nearly circular one, length 15 mm., breadth 16 mm.

This species belongs to the type of *Orthis lenticularis*, of the Upper Helderberg Group of New York, though specifically it does not resemble any N. American form. It is represented in the Devonian sandstone of Ereré by only a few very small specimens; many specimens of larger size were, however, obtained from the Rio Mæcurú. Two or three small specimens were found in the sandstone of the Rio Curuá. (Morgan Exs., 1870 and '71; Geol. Comm., 1876.)

Orthis Harttii, sp. nov.

Shell of medium to large size, transverse, subplano-convex, or with the ventral valve slightly convex on the umbo. Dorsal valve broadly subovate in outline; ventral, transversely subelliptical. Hinge line short, equal to about one-third to one-half the width of the shell. Surface marked with fine, radiating raised lines.

Ventral valve broadest near the middle; proportions of length to breadth about as 2 to 3, or length and breadth nearly equal. There is an undefined, shallow, and rather narrow, median sinus, which causes a slight indentation in the anterior margin of the valve. It commences some distance forward of the beak, and is often scarcely developed at all. Beak of medium size, prominent and acutely pointed, and projecting a short distance beyond the hinge line. The surface of the valve curves up rapidly from the hinge line toward the middle of the valve, but all the median and anterior portion of the valve is broadly flattened, and at times depressed to form the sinus.

Dorsal valve moderately convex, and broadest just anterior to the middle, the margins curving rapidly outward and forward from the beak to the point of greatest width, in front of which the margins form a regular curve, so that, as a rule, the valve has quite a perfect, broad-ovate outline. Along the median line the valve is usually broadly, but not strongly, elevated in an undefined prominence, reaching from near the beak to near the front of the valve. This elevated portion is rounded on top, or is marked by a faint longitudinal depression. It broadens rapidly forward, at the same time decreasing in height; near the middle of the valve its width equals about one-third that of the valve, or a little more; at the front it is one-half the width of the valve; at the sides it rounds over rapidly toward the lateral and posterior margins. Beak small and pointed; hinge area short, triangular.

In the interior of the dorsal valve there exists a rather small, but prominent and projecting, cardinal process, and moderately heavy dental plates, which latter diverge at an angle slightly less than a right angle. Septum broad, very slightly elevated, and reaching nearly to the middle of the valve. Muscular impressions of the ventral valve large and extending beyond the middle of the valve. They broaden rapidly from the beak forward, attaining their greatest breadth near the front, which is slightly rounded. A medium-sized septum separates them to the front. Surface marked with fine, closely placed, radiating raised lines which are sometimes slightly broader, at others slightly narrower, than the intervening striæ.

A dorsal valve measures, length 25 mm., breadth 30 mm.; a ventral valve, length 23 mm., breadth 32 mm.

This species apparently belongs to that group of Orthis, in which Prof. Jas. Hall has placed *O. Vanuxemi*, *O. leucosia*, *O. penelope* and *O. cyclas* of the Hamilton group of New York State, with the characters of which the new shell agrees quite perfectly in the dorsal valve, and also in the ventral valve, excepting that the latter is sometimes proportionally broader than the dorsal.

Quite abundant in the Devonian sandstone of the Rio Mæcurú, and also found at the Rio Curuá locality. (Geol. Comm., 1876.)

Streptorhynchus Agassizii Hartt, MS.

Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 248, pl. IX, 1874.

In the large collection of this species, made on the Rio Mæcurú by the Geological Commission in 1876, there are to be noted only a few variations beyond those already recorded in the original description of the species. The forms from the two localities, Ereré and the Mæcurú, are very similar. Among the Mæcurú specimens are examples in which the dorsal valve is more convex than is usually the case with the Ereré forms, and the beak of the ventral valve is sometimes more elevated. The dental plates at times reach forward a short distance into the valve, and the cardinal process is generally broader than in the Ereré forms; but there seem to be no other differences of importance.

This species is the most abundant one in the Devonian sandstone of Ereré. It is nearly equally common in the sandstone of the Rio Mæcurú, but only a few very small specimens were brought from the Curuá. (Morgan Exs., 1870 and '71; Geol. Comm., 1876.)

Strophodonta perplana Hall.

Strophomena perplana Conr., Jour. Acad. Nat. Sci., VIII, p. 257, 1842. *Strophomena pluristriata* Conr., idem., p. 259. *Strophomena delthyris* Conr., idem., p. 258. *Strophomena crenistria* Hall, Rept. Fourth Geol. Dist. N. Y., p. 171, 1843. *Strophomena* (*Strophodonta*) *fragilis* Hall, Tenth Rept. State Cab. N. Y., p. 143, 1857. *Strophodonta fragilis* Hall, Rept. Geol. Survey of Iowa, p. 496, 1858. *Strophodonta perplana* Hall, Palæont. New York, IV, pp. 92 and 98, 1868.

This common species of the Devonian of New York State, ranging there through the Upper Helderberg, Hamilton and Chemung groups, occurs very abundantly in the Devonian sandstones of the Rios Mæcurú and Curuá, and in these localities undergoes many of the variations peculiar to it in N. Y. It sometimes attains a very large size. (Geol. Comm., 1876.)

Spirifera duodenaria (?) Hall.

Delthyris duodenaria Hall, Geol. Rept. 4th Dist. N. Y., p. 171, 1843. *Spirifer duodenaria* Hall, Twelfth Rept. State Cab. N. Y., p. 88, 1859. *Spirifera duodenaria* Billings, Canadian Jour., p. 256, 1861; Geology of Canada, p. 372, 1863; Hall, Palæont. N. Y., IV, p. 189, 1868.

The commonest species of Spirifera at the Rio Mæcurú locality is one which belongs very near to *Spirifera duodenaria*, if it is not identical with it. The Brazilian variety is sometimes more transverse than *S. duodenaria*, of New York. The plications of the shell are generally of the same size, but are sometimes smaller. The ventral sinus is of more uniform size in the Brazilian, than in the American variety, and seldom becomes as broad at the front. The cardinal extremities are never much flattened in the dorsal valve, and never at all in the ventral, though this portion of the valve is almost always smooth. The depressions intervening between the plications are generally narrower than the plications themselves, and are regularly rounded. The hinge-area is narrow as in *S. duo-*

denaria, and in this character alone does it appear to differ from *S. speciosa* Schloth., of England and Germany. There exists in the collection of the Geological Commission a fragment of a ventral valve of very large size, five or six times that ordinarily attained by this species.

Very abundant in the Devonian sandstone of the Rio Mæcurú, but not found at either of the two other Devonian localities. (Geol. Comm., 1876.)

Spirifera Derbyii, sp. nov.

Shell of medium size, transverse; broadly semi-elliptical in outline; proportions of length to breadth about as 3 to 4; hinge line slightly shorter than the width of the shell; cardinal angles regularly rounded. The lateral margins, together with the anterior, form quite a regular, broad, semi-elliptical curve, slightly indented in front, where the fold and sinus reach the margin.

Dorsal valve moderately gibbous, and most elevated just posterior to the middle, towards which the surface arches up rapidly from the beak, but it curves down more gradually toward the front, the surface being slightly flattened on the fold, anterior to the middle. From the median fold the sides slope quite regularly to the lateral margins, and are nearly straight. Beak small and only slightly produced beyond the hinge line; median fold prominent, much elevated, and increasing quite rapidly in size toward the front. At the beak it is very fine, and rounded on top, but toward the front it becomes flattened. Throughout its entire length it is quite narrow above; its sides are broad and straight and slope abruptly downwards. Proportions of the width of the fold on top to its width below, at the front margin, about as 1 to 3. There are on each side of the fold five regularly rounded, simple plications, and generally a sixth indistinct one can be made out. These plications are very much smaller than the fold, and they are separated by rounded depressions of equal or slightly greater width. The first three plications on either side are well defined and begin quite close to the beak; the fourth, fifth and sixth are successively smaller and more flattened. The bases of the cruræ on each side of the beak are quite broad and heavy.

All the specimens definitely referable to this species are dorsal valves; there was found, however, a fragment of the ventral valve of a Spirifera, which may belong to this species. It has a moderately deep, rounded sinus, and six rounded plications on each side. The hinge area is of moderate width and curved; the beak, small and neither much elevated nor strongly incurved. Size of the largest dorsal valve found; length 25 mm., breadth 33 mm.

There seems to be no species of Spirifera in the Devonian of N. America with which the form under discussion can be compared. It has the appearance of a much lengthened *S. duodenaria.* Only three specimens have been found, a dorsal and a ventral (?) valve, in the sandstone of the Rio Mæcurú, and a small dorsal one in the sandstone of the Rio Curuá. (Geol. Comm., 1876.)

Spirifera Pedroana Hartt, MS.

Rathbun, Bull. Buff. Soc. Nat. Sci., I. no. 4, p. 237, pl. VIII, 1874.

Collections made since the original description of this species was published have furnished some new forms of Spirifera, very closely related to this species, if not identical with it. From the want of sufficient material to better characterize these varieties, I have placed them provisionally in the species *S. Pedroana.* We can separate the specimens into two general varieties, in the first of which the ventral valve has a rather broad hinge area, very slight curvature of the surface from the beak to the front margin, and also well developed, rather large and long, dental plates, which sometimes reach nearly to the front of the valve. In the character of the dental plates this variety approaches *S. Elizæ* Hartt, but it always has well marked plications, by which the two species can be readily distinguished. In the second variety, which is connected to the first by many intermediate forms, the ventral valve is much less convex, very slightly curved, with the margins very regularly curved, and the cardinal extremities rounded. On either side of the median sinus there are at times as many as twenty-four plications, and such examples often resemble the flattened forms of *S. medialis*, of the Hamilton group of New York. This extreme variety may eventually prove to be distinct from *S. Pedroana.*

The localities at which the different varieties of this species have been found are as follows: Devonian sandstone of Ereré, very abundant; Rios Mæcurú and Curuá very rare, especially the typical forms; but several odd varieties were obtained from these localities. In the collection from the Curuá there is a single large specimen, having a width of 70 mm. At the falls of Teuapixima on the Rio Mæcurú, there is a fine-grained micaceous sandstone, containing *S. Pedroana* and *Rhynchonella dotis.* The former occurs of small size and is usually quite transverse, with a thin shell.

(Morgan Exs., 1870 and '71; Geol. Comm., 1876.)

Spirifera Elizæ Hartt, MS.

Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 239, plates VIII and IX, 1874.

Although this species resembles very much *S. Pedroana* in some of its varieties, intermediate forms to unite the two are wanting. This form is quite rare in the Devonian sandstone of Ereré, the only locality in which it has been found. (Morgan Exs., 1870 and '71; Geol. Comm., 1876.)

Spirifera Buarquiana, sp. nov.

Shell attaining a large size, gibbous, transverse, subelliptical in outline, and with the breadth nearly two and one-half times the length; hinge line much shorter than the width of the shell; surface plicate.

Dorsal valve most convex near the middle, the surface first rising abruptly upward along the fold from the beak, for a short distance, and then arching strongly and quite regularly to the front margin. From the median fold to the lateral margins, on either side, the surface slopes very regularly and is nearly straight. The entire posterior part of the valve on both sides of the median line is very much inflated, and the slopes from there toward the hinge line are very abrupt. Beak very small and scarcely elevated above the hinge. Fold of medium size and enlarging with moderate rapidity toward the front, flattened on top and with its sides straight and abrupt. Its width above equals about one-half its width at the base, and its height at the front equals about one-third its width at the same point. On each side of the median fold are eight prominent, regularly rounded, simple plications, separated by slightly narrower, rounded depressions. There exists toward the front a single, well defined line of growth. Length of valve about 25 mm. or slightly more, breadth about 64 mm.

The large dorsal valve, above described, has been taken as the type of the species. Not being perfect it was impossible to entirely complete the description of the shell. There are besides the specimen described five or six dorsal and ventral valves of smaller size, which, though they present in a general way the characters of this species, yet differ so much from it in some details, as to render their identification with it somewhat uncertain. These forms are all from the Devonian sandstone of the Rio Mæcurú. (Geol. Comm., 1876.)

I take pleasure in dedicating this species to Dr. Buarque de Macedo, chief of the department of Public Works of Brazil, to whom Science is greatly indebted for his constant support of the best interests of the Geological Commission.

Spirifera, sp. indet.

There is a single large dorsal valve of a Spirifera, which bears some resemblance to those varieties of *S. granulifera* of the Hamilton group, having the cardinal extremities rounded. The surface arches strongly and regularly from side to side, and also strongly from the front margin to the beak, which latter is prominent and strongly incurved. There is no flattening at the cardinal extremities. Near the beak the fold is narrow, low, rounded, and marked with a slight longitudinal depression along the middle. The hinge line is slightly shorter than the width of the valve. There are, on each side of the fold, thirteen or fourteen very low, rounded, almost flattened plications, which are rather closely arranged, and the surface is also marked with several rather strong lines of growth. The width of this specimen is about 50 mm., length 38 mm.

Devonian sandstone, Ereré. (Geol. Comm., 1876.)

Spirifera Valenteana Hartt, MS.

Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 241, pl. VIII, 1874.

Of this species only one specimen has been found, the one from which the original description was made. Devonian sandstone, Ereré. (Morgan Ex., 1871.)

Spirifera Harttii, sp. nov.

Shell rather above the medium size, transverse, and with the proportions of length to breadth about as 7 to 11; in outline transversely subelliptical; hinge line slightly shorter than the width of the shell; cardinal extremities rounded, the greatest width of the shell being slightly anterior to the hinge line.

Dorsal valve moderately convex, the surface rising with gentle, regular curvature from the front margin to near the beak, toward which it bends abruptly downward, causing the beak to be somewhat flattened or apparently pressed down from behind. The valve is slightly flattened at the cardinal extremities and for some distance inward close to the hinge line, in front of which the umbonal region is strongly inflated over a great width. From side to side, across the middle, the curve of the surface is rather gentle and quite regular. The median fold is distinct quite to the beak, but on the posterior portion of the valve it is not much elevated above the general surface; it increases only gradually in height, but quite rapidly in width, its width at the front equalling about one-fourth that of the valve. It is regularly rounded from side to side, but on the anterior half it is marked with two longitudinal, shallow and narrow, but defined depressions, giving it there a three-lobed character. In one specimen the central lobe is slightly broader than the laterals; in another the central lobe is the narrower. On each side of the fold are eight simple, rounded plications, separated by slightly narrower, rounded depressions, the plications growing successively smaller in size toward the sides, and the more lateral ones bending slightly outward as they extend from the hinge line toward the margin. The plications are not very distinctly marked on the posterior part of the valve. Only two dorsal valves of this species are known. The larger is imperfect, but the smaller has the following dimensions; length 21 mm., breadth 33 mm., depth of dorsal valve 5.5 mm. Ventral valve unknown.

This species of Spirifera is readily distinguished by the three-lobed character of the dorsal median fold. In all of the other Devonian species from Brazil, the median fold is simple.

Devonian sandstone, Rio Mæcurú. (Geol. Comm., 1876.)

Spirifera mæcuruensis, sp. nov.

Shell minute, gibbous, with rounded cardinal extremities, and about four low, broad, rounded plications on the ventral valve.

Ventral valve very convex; length and breadth about equal; in outline forming obliquely a nearly square figure, but with the anterior margin of the shell slightly rounded. The surface arches strongly upward from the front, along the median line, to a point a short distance back of the middle of the valve, whence it curves slightly downward to the beak. Beak large and prominent, and much extended behind the hinge line, but only slightly incurved. Hinge area broad, triangular and very slightly concave; inclining strongly forward from the beak, so as to form an angle of about 110° to 120° with the plane of the shell margins. The distance from the hinge line to the beak is equal to nearly one-third the entire length of the valve, and in the triangular figure formed by the hinge area, the base, represented by the hinge line, is equal to about one and one-half times the length of each of the other two sides. Cardinal margins not sharply defined, the surface curving rapidly over from the hinge area into the general surface of the valve. Length of the hinge line equal to nearly two-thirds the width of the valve; cardinal extremities regularly rounded; fissure large, triangular, but widening only gradually from the beak toward the hinge line, where its width is about one-fourth the length of the hinge. A shallow, rounded median depression extends from the beak to the front margin. It is bordered on each side by a rounded fold of about its own width, which, however, descends much more rapidly on the outer side than on the inner, to another much less defined depression, reaching quite to the cardinal margin. From these lateral depressions outward the valve is slightly convex, or forms a low, very broad fold which extends to, and includes, the cardinal extremities. The margins of the shell are made very sinuous by these foldings of the surface. Length and breadth of the ventral valve each about 5.5 mm. Dorsal valve unknown.

This very small species of Spirifera resembles much *S. disparilis* Hall, of the Corniferous limestone of New York. It is readily distinguished from the North American form, however, by its smaller size, greater proportionate length, flatter hinge-area and different character of plications, etc.

Only a few specimens were obtained; these were all found in the sandstone of the Rio Mæcurú. (Geol. Comm., 1876.)

Ambocœlia (?) sp. indet.

There were encountered in the fossiliferous sandstone beds of the Rio Curuá several very small spiriferoid shells, resembling much in shape *Ambocœlia umbonata* Hall, of the Hamilton Group of New York State. The specimens were all, however, in too imperfect condition to permit of proper identification.

Cyrtina (?) **Curupira** Rathbun.

Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 242, pl. x, 1874.

Quite rare in the sandstone at Ereré. (Morgan Exs., 1870 and '71.)

Retzia Jamesiana Hartt, MS.

Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 243, pl. x, 1874.

A number of specimens of Retzia, identical with the *R. Jamesiana* of Ereré, were obtained from the Devonian sandstone of the Rio Mæcurú. From the same locality there are also other specimens, differing from the above in having more prominent and subangular plications, and a second variety has a much broader shell. It is doubtful whether these two latter forms should be included in *R. Jamesiana* or be separated from that species.

Devonian sandstone, Ereré. (Morgan Exs., 1870 and '71; Geol. Comm., 1876.) Rio Mæcurú. (Geol. Comm., 1876.)

Retzia Wardiana Hartt, MS.

Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 245, pl. x, 1874.

A few specimens of Retzia, which probably represent only a variety of *R. Wardiana*, are contained in the collections made on the Rios Mæcurú and Curuá. They agree in form with the Ereré specimens, but the plications on the shells from the two former localities are slightly larger, and fewer in number, there being about twelve on each valve.

Devonian sandstone, Ereré. (Morgan Exs., 1870 and '71; Geol. Comm., '76.) Rios Mæcurú and Curuá. (Geol. Comm., 1876.)

Rhynchonella ererensis, sp. nov.

Shell of large size, suborbicular in shape and marked with prominent, separated plications; length only very slightly greater than the width; thickness through the two valves apparently nearly equal to the width.

Dorsal valve subcircular in outline with a slightly projecting, sharply pointed beak; cardinal margins moderately concave and extending far forward. Viewed from the side, the surface rises rapidly upward from the beak, along the median line, in quite a regular curve for about one-half the length, whence to near the front the surface is quite straight, but slightly rising. It curves abruptly downwards toward the ventral valve, and is much flattened on each side of the front margins of both valves. From side to side the curvature of the dorsal valve is very strong, but not regular, the valve being somewhat flattened along the median line, especially toward the umbone.

The median fold begins near the centre of the valve, and increases only slightly in prominence towards the front. Its width is about two-fifths that of the valve, and it is marked with four prominent, rounded or sub-angular plications, which are separated by similar depressions. On each side of the fold there are six well defined plications, and besides these exist one or two very indistinct ones near the hinge. The plications nearest the fold are the most prominent, being slightly smaller than those of the fold; they are rounded on top or slightly angular, and each slopes down more gradually on its outer than on its inner side. The depressions separating the plications are from two to three times the width of the latter. The plications are only faintly indicated on the umbonal region; they cause the anterior margins of both valves to be strongly digitate. The median septum of the ventral valve reaches about half way to the front; it is prominent and heavy near the beak, but grows gradually more slender forward, being reduced to a mere line near the centre of the valve.

The entire length of the shell is 28 mm., width 26 mm., depth of the dorsal valve 15 mm., width of fold at the front about 11 mm.

Only a single specimen of this large species of Rhynchonella was obtained; this is the cast of a dorsal valve, with a portion of the ventral valve attached. It is readily distinguished from the other species recorded in this paper, by its larger size, greater proportionate length, and the more extended, pointed beak of the dorsal valve.

From the Devonian sandstone of Ereré. (Geol. Comm., 1876.)

Rhynchonella (Stenocisma) dotis (?) Hall.

Rhynchonella (*Stenocisma*) *dotis* Hall, Palæont. of New York, IV, p. 344, pl. LIV, 1867; Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 246, pl. VIII, 1874.

This species was first recorded from Brazil in the report of the Morgan Expeditions referred to above. At that time only two specimens were known from the Devonian sandstone of Ereré. These were both dorsal valves, which agreed quite closely in their characters with *Rhynchonella dotis* of the Hamilton group of New York. The Geological Commission discovered no more specimens of this species at Ereré; but in the sandstone beds of the Rios Mæcurú and Curuá were found many specimens of Rhynchonella, representing several varieties, of which the most are closely connected together and to the Ereré variety, by intermediate forms. Some of the varieties, however, present differences which may necessitate their being separated eventually from the commoner form. The result of the studies made on these varieties of Rhynchonella indicate that this species from Brazil may prove to be as closely related to some other of the N. American species as to *R. dotis*; but I was unable to make comparisons with a sufficiently large collection, and thus it has seemed best to retain the species as it is for the present.

As a rule, the shell of the Brazilian form is more or less transverse, or has the length and breadth nearly equal. Ventral valve short-ovate in outline; dorsal valve very short-ovate or transversely subelliptical. Of the ventral valve the beak is small, quite sharply pointed, and strongly incurved. The posterior margins diverge at an angle of about 105° to 115°, and are nearly straight. Anterior margin broadly, but not deeply, indented by the sinus. The surface of the valve is generally much flattened toward the front, and curves rapidly downward toward the front and lateral margins.

Dorsal valve very convex, the surface rising regularly and rapidly from the beak to near the anterior margin, toward which it curves down abruptly. The fold begins a little posterior to the middle and increases gradually in size forward, its width at the front equalling two-fifths to one-half the width of the valve.

There are from fourteen to eighteen plications on each valve, of which from three to four occupy the fold and two to three the sinus. Size of a large specimen; length 18 mm., breadth 23 mm.; but this is above the average. Although the sinus and fold are both generally well defined at the sides, yet on many of the smaller specimens they are only slightly marked, and in a few examples there are either two or five plications on the fold, and two or four in the sinus. These are rounded or subangular on top, and the depressions separating them are subequal in size, or slightly narrower or broader.

From the Rio Mæcurú there is a variety resembling much in appearance *R. Horsfordi* Hall. It has finer plications and a greater proportionate breadth than the common Brazilian form, and the fold bears five plications. In a fine micaceous sandstone at the falls of Teuapixima, on the Rio Mæcurú, were found small specimens of this species, resembling more the Ereré than the Mæcurú variety. The shell of this form is very thin and delicate. At the same locality were encountered *Spirifera Pedroana* and *Tentaculites Eldregianus*, but no other fossils.

Ereré. (Morgan Ex., 1871.) Rios Mæcurú and Curuá. (Geol. Comm., 1876.)

Amphigenia elongata Hall.

Pentamerus elongatus Vanuxem and Hall, Reports Third and Fourth Geol. Dists. N.Y., pp. 132 and 34, 1842 and '43. *Meganteris elongatus* Hall, Tenth Report on the State Cabinet, N. Y., p. 123, 1857. *Rensselœria elongata* Hall, Palæont. of N. Y., III, p. 453; Twelfth Report on the State Cabinet, N. Y., p. 37, 1859. *Stricklandia elongata* Billings, Canadian Jour. no. XXXIII, p. 268, 1861; Geology of Canada, p. 371, 1863. *Amphigenia elongata* Hall, Palæont. of N. Y., IV, p. 383, pl. LIX, 1867.

This large species of Brachiopod is very abundant in the sandstone beds of the Rios Mæcurú and Curuá. The moulds of the shells are generally found in a perfect state of preservation, often finely representing the internal characters. In its younger stages of growth the shell is usually short-ovate in outline, afterwards becoming elongate-oval and often subcylindrical in general shape. A large specimen has a length of 100 mm., and a breadth of 45 mm. The only marked difference noted between the Brazilian form and the North American, is the absence of radiating raised lines on the former; but this is probably due to the coarse character of the rock in which the specimens were found.

Rios Mæcurú and Curuá. (Geol. Comm., 1876.)

Terebratula Derbyana Hartt, MS.

Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 236, pl. X, 1874.

This species was obtained at Ereré in great abundance in 1876 by the Geological Commission. Specimens of larger size than before known were collected by them, but none giving a clearer idea of the true relations of the species. The largest specimen found measures in length 14 mm., in breadth 10 mm. From the Rio Curuá was procured a ventral valve of a small specimen of Terebratula, probably belonging to this same species.

Ereré. (Morgan Exs., 1870 and '71; Geol. Comm., 1876.) Rio Curuá. (Geol. Comm., 1876.)

Tropidoleptus carinatus Hall.

Strophomena carinata Conr., Ann. Geol. Rept. of N. Y., p. 64, 1839. *Leptæna laticosta* Hall, Owen and others. *Tropidoleptus carinatus* Hall, 10th Rep. St. Cab. N. Y., p. 151, 1857; Palæont. N. Y., IV, p. 407, pl. LXII, 1867; Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 254, pls. IX and X, 1874.

The description of the Brazilian form, in the Bulletin of the Buffalo Society of Natural Science, referred to above, was made from a few specimens collected at Ereré in 1871. The collection made by the Geological Commission in 1876, however, contains many varieties resembling more closely the species as it is known in N. America. This last collection has also many very large specimens.

The length and breadth of the younger shells are sometimes nearly equal, and the cardinal extremities are rounded or acutely angular. In the older forms the shell is frequently transversely subelliptical. The ventral valve is often subcarinate along the middle, the carina including from one to three plications, and the central plication of this valve is always the larger, whether the carina exists or not. The younger shells are not carinate. A depression, corresponding to the carina of the ventral valve, usually exists in the dorsal valve. The largest specimen examined has a length of 31 mm., and a breadth of 42 mm.; there are also many other specimens in the collection nearly equalling this one in size.

Rare at the Ereré locality. (Morgan Ex., 1871; Geol. Comm., 1876.) Very abundant on the Rios Mæcurú and Curuá. (Geol.

Comm., 1876.) This species was also found by Mr. A. Agassiz, associated with *Vitulina pustulosa*, in Devonian deposits on the island of Coati, Lake Titicaca, Bolivia.

Vitulina pustulosa Hall.

Vitulina pustulosa Hall, 13th Rep. St. Cab. N. Y., p. 82, 1860; Palæont. of N. Y., IV, p. 410, 1867; Rathbun, Bull. Buff. Soc. Nat. Sci., I, no. 4, p. 255, pl. IX, 1874.

This species is very abundant in the sandstone beds of Ereré and the Rio Mæcurú, and the specimens from these two localities agree quite closely with one another in all their variations. A slender septum is often preserved in the ventral valves from the Mæcurú, and specimens from this locality often have more prominent plications than those from Ereré. Only a few very small specimens were found on the Rio Curuá.

Ereré. (Morgan Exs., 1870 and '71; Geol. Comm., 1876.) Rios Mæcurú and Curuá. (Geol. Comm., 1876.)

CONCLUSIONS.

To aid in comparing the faunæ of the three Amazonian Devonian localities, there is given in the following table a list of the species described in the preceding pages, with the locality or localities at which each was found.

By reference to this list it will be seen, that of the twenty-one species recorded from the Mæcurú, thirteen were also found on the Curuá, all the commoner species of the former locality, excepting *Spirifera duodenaria* (?), being represented at the latter place. The relationship existing between the Ereré fauna and the Mæcurú is not so close. No Lingulæ were obtained on the Mæcurú, though two species were found in the Ereré sandstone. *Chonetes Comstockii*, so abundant, and often of large size, at Ereré, is rare on the Mæcurú, and *C. Herbert-Smithii* is not found there at all. *Spirifera Pedroana*, *Retzia Jamesiana* and *R. Wardiana*, all abundant at Ereré, are very sparingly represented on the Mæcurú.

On the other hand the common Mæcurú species, *Orthis Harttii*, *Strophodonta perplana*, *Spirifera duodenaria* (?) and *Amphigenia elongata* do not occur at Ereré; and there are several types of Spirifera and a Productella confined to the Mæcurú beds. *Chonetes Freitasii*, *Orthis Nettoana*, *Rhynchonella dotis* and *Tropidoleptus carinatus* are very abundant in the Mæcurú beds, but in the collection from Ereré they are represented by only a few specimens each. *Streptorhynchus*

Agassizii and *Vitulina pustulosa* are about equally abundant at the two localities.

List of Para Devonian Brachiopods.	*Ereré.*	*Mæcurú.*	*Curuá.*
1. Lingula spatulata (?) Hall	*		
2. Lingula ererensis Rathbun	*		
3. Lingula Rodriguezii Rathbun	*		
4. Lingula Stauntoniana Rathbun	*		
5. Lingula Graçana Rathbun	*		
6. Discina lodensis Hall	*		
7. Productella mæcuruensis Rathbun		*	
8. Chonetes Comstockii Hartt	*	*	
9. Chonetes Freitasii Rathbun	*(?)	*	*
10. Chonetes Onettiana Rathbun	*		
11. Chonetes Herbert-Smithii Hartt	*		
12. Chonetes curuaensis Rathbun		*	*
13. Chonetes (sp. indet.)		*	
14. Orthis Nettoana Rathbun	*	*	*
15. Orthis Harttii Rathbun		*	*
16. Streptorhynchus Agassizii Hartt	*	*	*
17. Strophodonta perplana Hall		*	*
18. Spirifera duodenaria (?) Hall		*	
19. Spirifera Derbyi Rathbun		*	*
20. Spirifera Pedroana Hartt	*	*	*
21. Spirifera Elizæ Hartt	*		
22. Spirifera Buarquiana Rathbun		*	
23. Spirifera (granulifera (?))	*		
24. Spirifera Valenteana Hartt	*		
25. Spirifera Harttii Rathbun		*	
26. Spirifera mæcuruensis Rathbun		*	
27. Cyrtina (?) Curupira Rathbun	*		
28. Retzia Jamesiana Hartt	*	*	
29. Retzia Wardiana Hartt	*	*	*
30. Rhynchonella ererensis Rathbun	*		
31. Rhynchonella dotis Hall	*	*	*
32. Amphigenia elongata Hall		*	*
33. Terebratula Derbyana Hartt	*		*(?)
34. Tropidoleptus carinatus Hall	*	*	*
35. Vitulina pustulosa Hall	*	*	*

Thus, as a rule, the commoner Mæcurú species are not found at Ereré, or are poorly represented there; and the same is true of the commoner Ereré forms on the Mæcurú. The genus Cyrtina (?) is peculiar to Ereré, and four genera, Productella, Strophodonta, Ambocœlia (?) and Amphigenia are only found on the Mæcurú.

As indicated in the foregoing pages, several of the Amazonian Devonian species are identical with North American Devonian. Beginning with the lowest Pará beds, those of the Mæcurú and Curuá, we find three species not occurring at Ereré, which are the same as North American species; they are *Spirifera duodenaria* (?), *Amphigenia elongata* and *Strophodonta perplana*. Of these species two are known only from the Corniferous limestone and Schoharie grit of North America, and *Strophodonta perplana* is found in the same formations and also in the Hamilton and Chemung groups. Of species much more abundant in the Mæcurú than the Ereré beds; *Tropidoleptus carinatus* is essentially a Hamilton group form; *Chonetes Freitasii* in its younger stages resembles *C. deflecta* of the Hamilton, but the larger, more abundant forms are represented in New York State by the larger type of Chonetes of the Corniferous limestone. *Rhynchonella dotis* of the Mæcurú is probably as closely related to some of the Corniferous Rhynchonellæ as to any of the Hamilton. I have been unable to make satisfactory comparisons of the Orthes, but they are of North American Devonian types.

Of the new species of Mæcurú Spiriferæ; *Spirifera mœcuruensis* is closely allied to *S. disparilis* of the Corniferous, and *S. Derbyi* resembles *S. raricosta* of the same formation.

Of the species peculiar to the Ereré beds, or most abundant there; *Spirifera Pedroana* appears to have related species in both the Corniferous and Hamilton groups of N. America; *Chonetes Comstockii* represents *C. coronata* of the Hamilton group; and *Retzia Jamesiana* is most like *R. lepida* of the same formation. *Spirifera granulifera* of the Hamilton group of N. America is represented at Ereré by a similar species, and *Lingula spatulata* is a Hamilton group species. As might be expected, *Streptorhynchus Agassizii* is as common to both the Mæcurú and Ereré beds as the North American species, which it represents, is common to the Corniferous, Hamilton and Chemung groups of New York State, etc.

It would appear from the preceding comparisons that the Ereré beds, as determined by their fossils, and as before indicated in my previous paper on the Ereré Brachiopods, are more closely related to the Hamilton group than to any other North American formation; but the Mæcurú and Curuá fossiliferous beds, although they contain a sufficient number of Ereré species to prove their close connection with the deposits at the latter place, yet they also bear a nearer relationship to the Corniferous group of New York State, than do the Ereré beds. In Pará we have the same general order of succession of species as in the Corniferous and Hamilton groups of N. America, and a similar intermingling of forms. The number of species of Brachiopods recorded from the Brazilian Devonian is so much smaller than that known from N. America, and the fossiliferous localities visited are so few, that we must expect further explorations to more or less alter the above conclusions. The difference in the character of the materials of the Mæcurú fossiliferous beds and the Corniferous is very marked. The former is composed mostly of rather coarse sandstones, the latter of limestones.

To complete the fauna of the Devonian of Pará there remains the large collection of Lamellibranchs and Trilobites from the Rios Mæcurú and Curuá, made by the Geological Commission in 1876. This collection is very extensive and represents a large number of species, which are mostly of North American Devonian types. From a hasty examination of the Lamellibranchs it seems probable that many of the species are identical with New York State forms. Several of the species are of large size, but I am unable to give here the names of the genera represented. Among the Trilobites are species of Homalonotus, Phacops and other genera. It is likely that the study of the Trilobites and Lamellibranchs would help to establish more clearly the relations of the Pará Devonian to that of N. America. At Ereré there were discovered, besides the new Brachiopods, two new species of Lamellibranchs, in addition to those previously described (Annals of the Lyceum of Natural History of New York, vol. XI, pp. 110 to 127, 1875.) They are of very small size and belong to the genera Nucula and Leda.

Tropidoleptus carinatus and *Vitulina pustulosa* were discovered by Mr. A. Agassiz in 1875 on the island of Coati, lake Titicaca, Bolivia, demonstrating the probable existence high up in the Andes of about the same Devonian horizon as occurs in Pará.

NOTES ON THE CORAL REEFS OF THE ISLAND OF ITAPARICA, BAHIA, AND OF PARAHYBA DO NORTE. BY RICHARD RATHBUN.

In the American Naturalist for July, 1876, I gave a short description of the coral reef skirting the outer shore of the island of Itaparica, in the bay of Bahia, Brazil. From a further examination of the reef and a study of the specimens procured from it, I am able to add a few items of interest to those previously given. I also wish to call attention to the existence of another reef, similar to that of Itaparica, to the south of the entrance to the Rio Parahyba do Norte. It was explored by Mr. John Branner of the Geological Commission. In shape and structure, as well as in the paucity of coral life upon it, this last agrees very closely with the Itaparica reef. It follows the trend of the shore, at a short distance from it, and between the reef and the shore there is an average depth of water of about six or seven feet only. The upper and outer portions of the reef are very irregular, but the inner part is comparatively smooth. No large corals are living upon it; at the northern end were collected a few small specimens of Porites, and toward the south a few millepores, Symphyllia (?), and Porites. Much of the bottom surrounding the reef is very rich in coral growth. No sections were obtained giving us a clue to its structure, which is, however, probably the same as that of the Itaparica reef.

In my former description of the Itaparica reef I stated that, while the lower portion was plainly made up in large part of true corals, the upper part appeared to contain only nullipores. I have since found that the worm tubes covering the surface of the reef enter very largely into its structure, probably to as great an extent as the nullipores, and give rise to an exceedingly hard, calcareous rock from which, ultimately, all traces of the worm-tube structure disappear. The worm tubes and nullipores evidently compose the entire upper half of the reef. The nullipores, in the upper portions, so far as my observations went, were all of the encrusting lichen kind, and resulted in a compact structure, showing a sort of wavy lamination which is due to the successive growths of nullipores. The large digitate nullipores, so common at Pernambuco and at many places in the bay of Bahia, are limited to the lower part of the reef, where they are associated with the true corals. At present nullipores are living in abundance only on the outer side of the reef, to a height of about one foot above medium low tide. Above the line of nullipores we find the entire upper surface of the reef coated with a layer of living worm tubes and large barnacles. The latter are generally broken off by the waves when dead, but the former remain, producing a loose structure near the surface, which becomes more compact below. The existence of nullipores in this upper portion indicates, however, that they lived on top of the reef at no distant time, and probably also that the reef has been elevated to a slight extent since then.

Within the reef the water is very shallow, being deepest near the reef and especially at and around the openings through it; it gradually shallows inwards toward the beach. The bottom of this shallow inner channel is covered with sand and fragments of all sizes of corals and shells. Corals were not found in an upright position in this channel, nor do living corals exist there at all. The coral fragments are all old, frequently much worn, and almost invariably covered with nullipore and bryozoan growths, also dead. They form beds of considerable thickness in places, often more or less consolidated, and are dug up to burn for lime. The species discovered among the fragments are all found living in various parts of the bay, excepting *Mussa Harttii*, which does not apparently live at present anywhere in the bay of Bahia. This extensive accumulation of broken corals, which must have been formed by the breaking off and heaping up of living corals from the surface of the reef by the breakers, when the reef was at a lower level, testifies to the exceeding richness of the coral life at that time. Corals have apparently ceased to be reef builders in the bay of Bahia.

Mr. J. A. Allen gave an account of the fossil birds of North America heretofore discovered, describing particularly a specimen procured through Mr. Scudder at Florisant, Col., interesting from its very perfect preservation, the feathers in fact being the most perfect yet shown in any fossil. Many of the bones, especially of the feet and wings, are also well preserved. The specimen is now the property of the Society, and has been described by Mr. Allen under the name of *Palæospiza bella*.[1]

Dr. T. Sterry Hunt read a paper on the Taconic system of North America.

General Meeting. October 2, 1878.

Vice-President Mr. S. H. Scudder in the chair. Twenty-seven persons present.

After the reading of the records, the chairman referred to the death of Professor Joseph Henry at the beginning of the past vacation, and introduced Prof. Asa Gray, who addressed the Society in some remarks upon the life and character of this eminent honorary member, whose death last spring — full of years and honors — had been so sensibly felt throughout the country and the scientific world.

[1] Bull. U. S. Geol. Surv. Terr., IV, 443-46, pl. i.

He regretted that the delicate health of Prof. Rogers prevented his attendance at this meeting, to portray both the scientific services and the personal character of his friend and associate of many years. In the absence of Prof. Rogers, no one present, and probably no surviving member of the Society, had known Prof. Henry so long and so intimately as himself. Most of the members present perhaps had hardly seen him; yet those who had enjoyed the privilege even of transient intercourse with him, must remember that thoughtful and benignant face, and may have seen the seriousness of a somewhat abstracted mein lighted up with the winning smile and the gracious attention with which he welcomed those who had occasion to confer with him or to seek his aid or advice.

Leaving to his surviving associates or compeers in other Societies, more germane to the subject, to portray his scientific services and researches, as they will be sure to do, Prof. Gray gave a brief sketch of Prof. Henry's life, from his birth at Albany, N. Y., near the close of the last century, his early education under restricted opportunities; his appointment as Professor of Natural Philosophy at the Albany Academy as soon as he had ceased to be a pupil there; the brilliant discoveries in electricity and magnetism, which made his name at once prominent throughout the scientific world; his translation to the College of New Jersey at Princeton in the year 1832; and thence to the Secretaryship of the then established Smithsonian Institution in 1846; and his death in its service on the 13th of May last. Some anecdotes of his boyhood were related, among them the incident of the accidental perusal of a small volume of lectures on experimental philosophy, which gave him his first perception of what knowledge was, and fixed the tenor of his life. The simple sense of duty which impelled Prof. Henry to interrupt a career of research of almost unequalled brilliancy, by an undertaking which was sure to absorb his best years in administrative and perplexing cares, was referred to; and to it was attributed the result, that the noble bequest of Smithson "for the increase and diffusion of knowledge among men" was thereby rescued from waste and misappropriation; its capital not only preserved but augmented, and its legitimate uses developed and fixed, after great opposition, in a manner which now commands general approval. When it is remembered that the Act of Congress which established the Institution permitted, if it did not invite, the devotion of the whole income of Smithson's bequest to what may justly be termed local uses, and when the early history of the institution comes to be written, it will be understood — Dr. Gray insisted — that the great benefits which the scientific world at large, and science in America especially, are receiving from it, are mainly owing to the practical wisdom, the catholic spirit, the just conception of the founder's intent, and the indomitable perseverance of its first Secretary and Manager. Prof. Henry's disinterestedness in accepting this position, to the detriment, and as it proved almost entire interruption, of his career as an investigator, was referred to, along with the fact that he seems to have anticipated this consequence, having remarked as he was leaving Princeton, that he was "sacrificing reputation to fame."

The development in this new position of rare talent as an administrator and in the conduct of affairs, was spoken of, as also the directly practical turn which was given to all his later researches by the duties he was called upon to perform as a trusted scientific adviser to more than one department of the Government, and particularly to the Light-house Board, in which he was for many years chairman of the committee on experiments, and during the later years President. In one line of investigations upon lighting he is said to have saved some hundred thousand dollars to the government; and his last illness is said to have supervened upon exposure on the sea-coast while engaged in those researches upon the propagation of sound and the perfecting of acoustic signals, to which the summer and autumn of his later years were devoted.

His serene simplicity and loftiness as well as kindliness of spirit were portrayed; his entire devotion to what he deemed his duty — often exhibited in the extreme patience with which he attended to the applications of projectors and crotchety discoverers who sought his advice. And much of the prominent influence which he wielded at Washington was attributed to his transparent and spotless character, the complete subjection of all considerations of personal advantage or even of personal ambition, and the atmosphere of purity in which his official as well as private life ever moved, and upon which never fell even the shadow of a shade.

The following paper was read: —

NOTES ON THE PHYSICAL GEOGRAPHY AND GEOLOGY OF TRINIDAD. BY W. O. CROSBY.

Trinidad is a typical example of a continental island. Its intimate relation to the continent of South America is shown not by its geographic contiguity alone, but also by its botany and zoology, and very strikingly by its topography and geologic structure. In all these respects, especially the last, it differs widely from all the other Caribee Islands, except Tobago.

South America appears to be a partially submerged continent; the true continental edge being sometimes a hundred miles or more to the seaward of the actually existing coast line. Around the north-eastern corner of the continent, the almost cliff-like declivity that marks the real border of the ocean is distant fifty to one hundred and fifty miles from the nearest dry land of the Main, and inside this line the soundings do not exceed one hundred fathoms. Rising from this zone of shallow water are all the Leeward Islands, or Lesser Antilles, and Trinidad and Tobago. These islands, composed wholly of stratified rocks, are essentially a part of the continent, and are strongly contrasted with the volcanic islands to the northward, which have their foundations in the abysses of the ocean.

Trinidad is usually described as a quadrangular plain of very moderate altitude, traversed by three parallel, east-west lines of elevation, the principal of which, called the Northern Mountains, skirts the northern coast with a breadth of from six to ten miles, and a mean altitude of about two thousand feet, thirty-one hundred feet being the maximum elevation.

These mountains, standing like a a wall between the Caribbean Sea and the low lands to the south, are composed of crystalline or semi-crystalline rocks, which are undoubtedly of great antiquity, the most recent dating, probably, from the lower Paleozoic. The remainder of the island is formed of much newer rocks; — older Cretaceous, the "Older Parian" of Wall and Sawkins, and lower and middle tertiary, the "Newer Parian" of the same authors. The tertiary beds largely predominate, the Cretaceous rocks occurring on the surface only in two narrow discontinuous belts. These mark the positions of prominent anticlinal axes, and form the main part of the other ranges of elevated land above indicated. One of these lines of hills lies about midway between the Northern Mountains and the southern coast, and ranges in height from five hundred to one thousand feet, while the third and least important range stretches along the south shore, with a maximum altitude of only seven hundred feet.

From the time of Humboldt to the present day, all observers have agreed that the Northern Mountains of Trinidad are but the eastern extension of the great littoral cordillera, or serrania, as the Spanish call it, of Venezuela, which presents a bold front to the Caribbean Sea for upwards of three hundred miles, and then bends southwesterly to form one of the two main branches of the Andes.

Bordered by this serrania on the north and west, and by the Orinoco on the south, is an extended plain, or llano, having a flat or gently undulating surface which, nowhere more than a few hundred feet above the level of the sea, is, on the east, and especially in the delta of the Orinoco, hardly sufficiently elevated to be regarded as dry land. This great plain is composed of secondary and tertiary rocks, and the recent deposits of the delta of the Orinoco. According to the published[1] observations of Mr. Wall, the secondary and tertiary strata, in the eastern half of this plain at least, are the chronological equivalents of the rocks of Trinidad. But the two formations are developed in different proportions on the main land. The Cretaceous beds are confined to the northern half of the plain, where they have a great thickness, forming a belt fully forty miles wide, which reaches high up on the serrania, constituting at some points one-third of its volume, and, in the States of Barcelona and Cumana, composing the highest summits. With this exception, the littoral cordillera of the Spanish Main, as far west as Caraccas at least, is composed of the same rocks as on Trinidad, and the structure is similar. There is little room to doubt that Trinidad, south of the Northern Mountains, is an isolated portion of the plain above described, which, probably in consequence of the greater disturbance which the rocks have experienced, is somewhat more elevated than the adjacent main.

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[1] Appendix to the "Report on the Geology of Trinidad."

In short, the region between the littoral cordillera of the Spanish Main and Trinidad, and the crystalline rocks to the south of the Orinoco and in Guiana, is a natural basin, which, since middle Secondary time, or possibly from a still earlier epoch, has been gradually silting up; and the process is not yet complete. The Gulf of Paria has an area of about twenty-five hundred square miles. It is a shallow body of water, the greatest depth, except in the immediate vicinity of the Dragon's Mouth, not exceeding twenty fathoms, with an average of less than ten fathoms. I have searched in vain for proof that this is an excavated basin. The land is certainly gaining, not wasting, along the western and south-western shores of the gulf; and such appears to be the case on the east side, except at a few salient points. Evidence is not wholly wanting, especially along the north side of the gulf, that it has resulted from a local subsidence; but I am more inclined to the view hinted at above, that it is a portion of the great basin of the Orinoco which has never been filled up. But, whatever the origin of the gulf, there can be no doubt that existing forces are rapidly obliterating it. Vast quantities of sediment are discharged into it by the Orinoco, Caroni, and other streams, and the delta of the first named river is steadily encroaching on the waters of the gulf. The annexation of Trinidad to the Continent by this means appears to be only a question of time. In fact, if the present conditions are maintained, the, geologically speaking, near future will witness considerable additions of terra firma to the north-east coast of South America. The southern half of the Orinoco delta will advance northward until it meets the southern coast of Trinidad and closes the Serpent's Mouth. The intervening water is now for the most part quite shallow, and the greatest depth is scarcely thirty fathoms. The action of the sea on the Trinidad coast, it is true, tends to widen the strait; but at the same time, the detritus thus formed, being deposited in the strait, serves to make it shallower; and, moreover, the encroachment of the sea on this coast must for a long time proceed very slowly on account of the range of hills — three hundred to seven hundred feet high, which the waves have just begun to act upon. When the geographic changes here indicated are complete, the main mouth of the Orinoco will have made an appreciable advance eastward; Trinidad will be included in its delta; and the Dragon's Mouth will form another principal mouth of this mighty river, discharging water directly into the Caribbean Sea.

The origin of the Dragon's Mouth itself is justly regarded as one of the most interesting problems in the physical geography of Trinidad; and various are the solutions which have been proposed. Subsidence, however, is a feature common to them all. According to the most recent view, that advanced by Mr. Guppy,[1] this subsidence is local, and results from a grand fault running in a N.–S. direction along the west side of the Dragon's Mouth, having the downthrow on the east, and producing at once the strait in question and the Gulf of Paria. I will preface my view with a statement of the principal facts.

The Dragon's Mouth (or Boca [2]), from the Point of Paria to the main land of Trinidad, is thirteen miles wide. The three islands — Monos, Huevos, and Chacachacare — lying in the eastern half of the Dragon's Mouth, divide it into four distinct channels or bocas. The first three bocas, reckoning from the east, average about one mile in breadth, while the fourth boca, Boca Grande, is over seven miles wide at the narrowest place. Pato Island lies too far to the south of the Boca Grande to be said to divide it. The bocas are deep, and the separating islands high and mountain-like. The maximum depths, beginning with Monos Boca, are 35, 60, 75, and 145 fathoms, respectively.

That subsidence has been the main cause of the bocas is rendered certain by an examination of the boca islands, and the cross sections, as determined by soundings, of the bocas themselves. The areas of these islands range from one and a half to three square miles, and the maximum altitudes from seven hundred to one thousand feet. They have precisely the forms and contours of the higher peaks of the adjacent mountains of Trinidad; and are, in fact, simply partially submerged mountains. They are deeply indented by bays; these, as a rule, however, have very plainly not been excavated by marine agency, but are mountain valleys and gorges, the lower portions of which have been invaded by the sea; and the bottoms of the bays, as already intimated, have in general the forms which this origin would require. Not less convincing, as pointed out by Mr. Guppy, are the partially filled up valleys of Carenage and Diegomartin, the true bottoms of which are undoubtedly below the present level of the sea.

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[1] Proc. Sci. Assoc. Trinidad, 1877, p. 104.

[2] Spanish for mouth.

We have no data by which to determine the period when this subsidence occurred, except such as is afforded by the degradation effected by the sea since reaching its present level; but this is so great as to indicate that the existing conditions have been maintained for a long time, perhaps even in a geological sense. The shores at most points, and especially where they face the trade wind, have the form of bold cliffs forty to four hundred feet high. Owing mainly to the moderate southerly dips which the rocks usually exhibit, the axis or crest of the range of the Northern Mountains lies at most points within from one to two miles of the northern coast; and it is interesting to speculate upon the magnificent cliffs which this shore will probably present when another mile of land has been removed. Not the least noticeable of the coast features of this part of Trinidad are the straight, tunnel-like caverns excavated by the sea, where it has taken advantage of a softer rock stratum, a decomposing mineral vein, or an intersection of well marked joint planes. These are well developed about the boca islands, and are not uncommonly from one hundred to two hundred feet in length. But all these evidences of marine action are confined absolutely to the level where the surf beats to-day, and above this line we find neither beach, cliff, nor cavern. The bocas are deeper than the adjoining seas on either side, being prevented from silting up by the powerful tidal currents which set through them.

It is commonly supposed that the Northern Mountains of Trinidad are a direct continuation of the mountains forming the peninsula of Paria, and that the bocas are simply depressions in what would be otherwise one continuous range. But to my mind nothing is clearer than that such is not the case. It needs but a glance at the map to show that the Trinidad mountains do not trend in a direction toward the Point of Paria, but to the south of it; while the Parian range exhibits an equal divergence toward the north. The two ranges, however far extended, would never connect. The boca islands lie directly in the course of the Trinidad range, and are plainly a part of it; and Pato, which is also on this line, is the last point where this chain appears above the waters of the Gulf. From the Gulf of Paria, at a distance of from five to ten miles, we have a good profile view of the Northern Mountains, from Tucutche westward. And nowhere, probably, can the gradual dying out of a mountain range be seen to better advantage than here; the gradation is almost perfect, each peak or summit being a little higher than the one that follows, until we come to the Monos Boca; beyond this the incline is supported, but not broken, by the boca islands, and continuing on the same line the eye finally rests on Pato; the profile, no less than the map, view proving this islet essentially a part of the Trinidad range. The Point of Paria, viewed from the south, presents the same appearance of a mountain range gradually approaching its vanishing point. The inclination of the axis, however, is steeper in this case; and to this circumstance, chiefly, we owe the absence of a string of islands matching those through which the Trinidad range tapers out. The Point of Peñas, nevertheless, is essentially such an island, being connected with the main only by a low and narrow isthmus.

The mountains of Paria and Trinidad form two parallel, overlapping ranges with trends slightly oblique to the general course of the cordillera to which they belong, and to the strike of the rocks composing them. We have here, then, simply a fine example of the *en échelon* arrangement of mountain ranges so well displayed in our own Appalachian system and characterizing mountain regions generally. And now we can see plainly what appears to have escaped the notice of observers heretofore, viz.: that in the Dragon's Mouth there are two radically different kinds of bocas. The Monos, Huevos, and De Navios bocas are depressions in the Trinidad range of mountains, cutting that range approximately at right angles; while the Boca Grande is the depression between two distinct ranges at the point where they overlap, and is, as we should naturally expect, much broader and deeper than the other bocas, and has a trend substantially parallel with the ranges which it separates.

The mountains of Tobago agree in lithology and structure with the Northern Mountains of Trinidad, and may, I think, be fairly regarded as another and last step in the *en échelon* plan of the Caribbean cordillera; and the interval between Trinidad and Tobago, having a maximum depth of sixty fathoms, is another Boca Grande. In such facts as this and the generally submerged condition of this part of the continental margin, we have evidence that the subsidence producing the Dragon's Mouth was general, not local. Farther west, in the State of Barcelona, there is another well-marked break in the littoral cordillera, and an examination of the maps seems to show that the *en échelon* plan characterizes this entire mountain system.

The rocks composing the Northern Mountains of Trinidad and the major part of the Parian range, were designated collectively as the "Caribbean Group" by Wall and Sawkins, in their Report on the Geology of Trinidad, published some twenty years since. These mountains are monoclinal. The strata almost everywhere exhibit southerly dips of thirty to sixty, or even more, degrees, and the beds to the north are presumably the oldest. The prevailing southerly dip is well expressed in the topography, the northern face of the mountains where the strata are broken approximately at right angles being very abrupt, with an average length of perhaps two miles; while the opposite slope, substantially parallel with the bedding, is two to four times as long, and correspondingly gentle. The ranges are cut transversely by numerous lateral valleys, which are for the most part deep and narrow, natural sections, frequently laying bare the very heart of the mountains. Some of these, at least, appear to have originated in transverse faults, the cliff giving rise to the remarkable waterfall of Maracas (three hundred and forty feet high) certainly demanding such an explanation for the valley of which it forms one wall. Notwithstanding the diversified and sharp-featured topography of these mountains, the geological explorer is much hampered by the paucity of rock outcrops; for sub-aerial decomposition goes on very rapidly under the influence of tropic rain[1] and heat; and, besides, such exposures as exist are usually practically inaccessible, on account of the tangled mass of vegetation that overruns every rood of uncultivated ground.

Mr. Guppy, in a recent paper[2] on the "Caribbean Group," says:—"These rocks attain collectively a thickness of more than ten thousand feet. The whole thickness of the group is probably much greater than this; for the evidence furnished by dip and other circumstances leads to the inference that a portion of the series, as developed in Venezuela, is inferior in position to any of the rocks exposed in Trinidad." This author considers the Parian strata as thrown down to the north of Trinidad by an east-west fault, and also finds topographic evidence for the existence of other lines of dislocation parallel with this one, having the down-throw in each case on the north, and augmenting the apparent thickness of the entire series. I have not seen the evidence indicated by Mr. Guppy, but to my mind the otherwise enormous volume of the "Caribbean Group" renders the existence of these faults highly probable.

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[1] Trinidad enjoys an annual rainfall ranging from 56 to 91 inches, with an average of about 80 inches.

[2] Proc. Sci. Assoc. Trinidad, II, 104.

That the rocks on the Point of Paria belong, in their normal position, below the Trinidad portion of the series, is evidenced not only by their stratigraphy, but also, as I think, by their more crystalline character. Following is Mr. Wall's description[1] of these rocks:

"Commencing at the Punta de la Pena, a well defined gneiss is encountered, containing green and light red mica, with a soft feldspar readily decomposing. . . . . There is also a green rock, consisting of talcose matter, with some chlorite and dark colored mica, and finely divided material, probably feldspathic and siliceous substances. . . . . In Megillones Bay the gneiss gradually loses the tabular structure, becoming massive and somewhat granitoid. . . . . Returning to the Punta de la Pena, and proceeding south-west, near Celeste Point, the green talcose rock is again observed, and seems here to graduate into the gneiss, no defined line of junction existing. A short distance beyond the Point it alternates with the gneiss in layers of two to four feet thick; to these a number of feldspathic beds are soon associated, the most definite of which is a mixture of quartz and white feldspathic base, exhibiting no foliation, but a tendency to planes of contact with the adjoining strata. After some distance, in which the precise nature of the rocks is rather ambiguous, the character of quartzose and mica slates is gradually assumed, becoming more micaceous on receding from the gneiss. The color is first green, afterwards light yellow and whitish."

The Northern Mountains of Trinidad present at most points the following section, in ascending order, from north to south: —

1. A series consisting largely of quartzite, in heavy beds; stratification usually thin and distinct, sometimes massive. This rock is generally, perhaps always, slightly micaceous. The mica occurs in minute spangles, and is aggregated chiefly along the planes of division

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[1] Report on the Geology of Trinidad, Appendix B.

that coincide with the bedding. The quartzite sometime appears little different from an indurated sandstone; at other points it passes, through the increase of mica, into distinct mica slate, which is, perhaps, the prevailing rock of this series. The mica slate is never very micaceous, and, as in the quartzite, the mica is not uniformly diffused through the mass, but is concentrated between the quartzose laminæ, which are quite thin and more schistose than in the preceding rock. The mica is always in a finely divided, and probably in many cases an incipient, state. In some beds, as noticed by Mr. Wall, the flakes of mica seem to enclose pellicles of graphitic matter. The most interesting rock of this division is a finely schistose greenish rock, which, having a base of quartz with, possibly, some feldspar, contains a large amount of an unctuous, green mineral, somewhat resembling chlorite at first view, but which is probably a hydro-mica. It is a massive, thick-bedded rock. Interstratified with all the preceding, and showing occasional transitions into the mica slate, are several varieties of a distinct argillite. This rock is finely laminar, or fissile and shaly, rarely massive. It is dark-colored, usually black, appearing to be always more or less carbonaceous, and occasionally distinctly graphitic. The partings are lustrous, and are not infrequently marked by a true mica. The accessory minerals in the foregoing rocks are limited to pyrite (occasionally chalcopyrite), quartz, gypsum, and calcite; the last two being quite rare. The pyrite and quartz are found in all the rocks described, but most abundantly in the argillite, and least so in the quartzite. Occasional beds are so highly pyritiferous as, on the oxidation of that mineral to assume a decidedly ferruginous aspect. The accessory quartz is in the form of lenticular veins, which are for the most part, but not always, conformable with the stratification. These veins have been well described and faithfully delineated by Messrs. Wall and Sawkins. They are very numerous in the argillite, and constitute a characteristic and important feature of the entire series.

2. Crystalline limestone in massive beds having in the aggregate a great thickness, varying in color from white to nearly black, sometimes decidedly ferruginous, and often with scattered spangles of silvery white mica. The limestones on Chacachacare appear to belong here.

3. Frequent alternations of the following rocks: argillites similar to those in the first series, frequently graphitic and often passing into mica slate, the latter rock being less distinctly micaceous than be-

low the limestone; hard sandstones, sometimes approaching quartzite, and occasionally decidedly ferruginous; conglomerates and thin beds and seams of calcareous matter. The phenomena of the quartz veins are even more characteristic of this series than of the first. The other accessory minerals are the same. It is noticeable that the veins of quartz rarely occur except in those rocks — argillite and mica slate — which, when subjected to lateral pressure as during the formation of folds and contortions of the strata, experience local partings of the layers in a direction parallel with the bedding, giving rise to lenticular cavities. The limestone, quartzite and massive sandstone are incapable of behaving in this manner, and such veins as exist in these rocks are usually transverse to the bedding. The amount of local contortion and faulting which all these Caribbean rocks have experienced, is very great.

The first and third series have approximately the same apparent thickness, and both exceed the second or limestone belt.

In the conglomerate that forms part of the series above the crystalline limestone, I have observed pebbles that were almost certainly derived from the quartzites and mica slate of the first series; but beyond what this implies we have no evidence of a lack of conformability between the different terranes above described. Unconformably overlying the third, however, is the compact limestone of the Laventille Hills and the small islands to the westward of Port of Spain. This is entirely distinct from the crystalline limestone and undoubtedly belongs to a more recent epoch than any of the rocks to the northward; and hence Mr. Guppy is right in urging that it should no longer be included in the "Caribbean Group." The compact limestone is rich in organic remains, but these are so obscure that it is only within the last decade that the fact of their existence has been certainly recognized. We are indebted to Mr. Guppy almost solely for the little that is known of the paleontology of this rock. The fossils so far made out are small bivalves resembling Nucula, and casts of small univalves like Murchisonia and Loxonema. Besides these there are according to Mr. Guppy a massive reef-coral and many serpuline fossils. This author regards the limestone as probably Carboniferous or Devonian, but I would assign it a greater age, the fossils that I have seen having a decidedly Cambrian aspect.[1] The rock itself is very compact and massive, of a dark bluish-drab to black color, and has a strong resemblance to the Trenton limestone of New York. Interstratified with it are occasional beds, one to twenty feet thick, of soft thin-bedded slates and shales which are frequently highly ferruginous and have polished and glistening surfaces. It is chiefly by means of these argillaceous beds that we are able to observe the dip of the limestone.

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[1] Mr. Guppy has provisionally identified two of the Gasteropods with the North American species, *Murchisonia anna* Billings and *Murchisonia linearis* Billings, both Cambrian species.

Besides many subordinate warpings, the compact limestone presents one grand anticlinal fold involving the whole of the formation so far as exposed. On the Laventille Hills, Point Gourde, and the island of Gaspari the limestone dips to the north,— toward the mountains; while on the Diego Islands and the Cotoras (or Five Islands) the dip is southerly. The dip is usually steep, thirty to seventy degrees. Pato, which I have not visited, probably belongs on the north side of the arch. The crest of the anticlinal has been removed by denudation, forming the east-west passage between the islands. The position of the limestone on the Laventille Hills would seem to indicate that the anticlinal experiences a southerly deflection at this point, conforming in trend with the base of the mountains, of which these limestone elevations are the foot hills. The evidence all favors the view that the limestone islands, like the boca islands, have been fashioned by atmospheric agents and were isolated by the same subsidence that produced the bocas.

The Caribbean Group, as thus limited, is probably all Pre-Cambrian, or, what is the same thing, Pre-Paleozoic. It has yielded but few fossils, and these are all from the highest beds, being found in strings and bands of calcareous rock, which, in the San Francois Valley, immediately north of the Laventille Hills, are intercalated in the mica slate and argillite forming the upper part of the third series. Here, again, we are indebted to Mr. Guppy for the totality of our knowledge. An interesting structure, probably organic, has been described by him under the name of *Eozoon Caribeum.* Two corals have been made out, one of which, a minute species, he names *Favosites fenestralis*, finding its nearest analogue in *F. fibrosa*; and the other is regarded as near *Petraia bina* Lonsdale. In addition there are distinct remains of Echinodermata; of these he says: [1]— "There are plates, stems, and spines scattered through the stone; the most perfect consisting of five ambulacral plates and four pairs of pores. Another specimen, though much broken, shows portions of at least twenty ambulacral or pseudo-ambulacral plates, somewhat resembling the Devonian Eleacrinus. In some of the calciferous slates from the same series, very similar remains occur, but no perfect or nearly perfect specimen has come to hand. Some of the fossils appear to be fragments of Cystidea.''

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[1] Proc. Sci. Assoc. Trinidad, II, 107.

While studying these rocks, I have frequently remarked the strong likeness which the "Caribbean Group" as a whole presents to the Taconian series of western Massachusetts and of the eastern United States generally. This agreement holds not only with respect to the lithological characters, as the preceding descriptions testify, but it is seen also in the monoclinal dips, the extensive dislocations parallel with the strike, and the general, but not entire, absence of organic remains. If what has been said of the age of the compact limestone be substantially correct, then in its relations to the lower Paleozoic formations, too, the "Caribbean Group" admits of correlation with the Taconian.

A vote of thanks was passed to Dr. J. W. Dawson, of Montreal, for some fine specimens of *Eozoon canadense.*

General Meeting. Oct. 16, 1878.

Vice-President, Mr. S. H. Scudder, in the chair. Twenty-eight persons present.

Prof. N. S. Shaler read a paper on the peculiarities in the growth of the Swamp Cyprus (*Taxodium distichum*).

Mr. C. S. Minot referred to some recent speculations on the homology of the endostyle of the Tunicates and the thyroid gland of the Vertebrates.

Dr. T. M. Brewer showed some additions to the collection of birds — a pair each of the American Scoter Duck and the Surf Duck, the gift of B. C. Clarke, Esq., and specimens of the Pomarine Skua, Leach's Petrel, and the Red Phalerope from the Smithsonian Institution.

The thanks of the Society were voted for both gifts.

Section of Entomology. Oct. 23, 1878.

Mr. S. H. Scudder in the chair. Seven persons present.

The following papers were read:

MUSEUM PESTS OBSERVED IN THE ENTOMOLOGICAL COLLECTION AT CAMBRIDGE. BY DR. H. A. HAGEN.

Ever since I have been working at the Museum in Cambridge, I have given especial attention to the Museum Pests destroying insects in the collection. Perhaps a notice of the species observed by me may be of interest.

The largest number of these injurious insects belongs to the family of Dermestidæ, five species of which I have noticed, three of them very destructive.

Dermestes lardarius was very abundant in my first work room, but is large enough to be easily detected, and did harm only in the first months. The number of skeletons of animals not cleaned and prepared was then very large, and actually swarmed with this larva in the attic rooms. I remember that on an unusually warm day in November, I saw the southern brick wall speckled with black spots, and going nearer, I was astonished that all were living beetles of *D. lardarius.* I have never since seen such a number of beetles together. Of course they could not be prevented from entering the work rooms through open windows, and I had for months a rather hard struggle with them. I decided to trap them with some old cheese put in a draw, and by killing the newly arrived two or three times in the day, I found out that they disliked the inhospitable reception. In the following years the skeletons were prepared, and for many years I have seen none of this species within the collection nor in the work room. Among the new collections added only one was thoroughly infested with *D. lardarius.* The species is easily recognized by the larger granulous jet black excrements of the larva; therefore it cannot exist to any extent in a well kept collection. But, as with Anthrenus, these excrements are soon transformed into powder by Psoci, if they are in the boxes. As Pastor Goeze remarked long ago, these live on excrements.

Much more dangerous and very frequent is the larva of *Attagenus megatoma.* During late years this insect has propagated to a fearful extent in many houses in Cambridge, and, as I believe, does half the share of all destruction ascribed to the "Carpet bug." In the arranged collection of the Museum it occurs only rarely, and I have always found out the crack or small split in the box through which the very thin and slender young larva entered. The insect is to be recognized by the small globular ochreous excrements. I consider this species one of the most dangerous pests, and keep very careful watch for it.

The other species of Attagenus, *A. pellio*, I have seen only two or three times alive in my work room, probably from insects arrived from Europe, where it is much more obnoxious and common than *A. megatoma*.

The genus Anthrenus is represented by three species, all equally dangerous, but not equally common.

The European *A. museorum* (*castaneæ* Melsh.) is apparently very rare here in collections of insects. I should say that I am even not sure if the specimens I saw in the boxes were not imported with European insects.

The other species, *A. varius* (*destructor* Melsh.) is the most common pest in the collection, especially in new additions, or in newly spread insects, when the boards are not directly put in well closing boxes.

It is remarkable that *A. varius*, which is by no means uncommon in Europe, is *there* rarely met as a museum pest, and is replaced in Europe by *A. museorum*, which is *here* rarely injurious.

A third species, *A. scrophulariæ*, the "carpet bug," has only been known to me since 1872 as an inhabitant of New England, and only for the last three or four years as a museum pest. It is now nearly as common as *A. varius*, and certainly more dangerous. The excrements of the Anthrenidæ consist of very fine light brown globules, not easily distinguished from the yellow ones of *A. megatoma*.

In studying somewhat closer the Anthrenidæ of the United States, I should like to draw the attention of Coleopterists to *A. thoracicus*. It is in some respects similar to the European *pimpinellæ*, and the difference between the two species is not yet clearly given. Dr. LeConte says simply,— differs from *A. pimpinellæ* by the orange colored suture of the elytra. Now it happens that the two typical European specimens of *A. pimpinellæ* in the collection have both a very visible orange suture. I looked therefore in the literature, and was still more puzzled to find that all authors, upon the accuracy of whose descriptions we are accustomed to rely, do not mention at all the orange color of the suture — so Gyllenhal, Erichson, and many others. The four figures I compared are rather indifferent ones (Olivier, Herbst, Scriba, Panzer), but in Panzer's figure the suture is at least indicated. Therefore Dr. LeConte was entirely justified in bringing this difference to the front. As I was not satisfied with the result of my researches, I compared every description I know of this species, and there found different statements by the following authors. I possess the copy of Geoffroy, formerly in Erichson's library, and with many marginal notes by him; where the species (I, 114) is determined by him as *A. pimpinellæ*, Geoffroy says: "la couleur rougeâtre occupe principalement le bas de la suture et la haut de cette même partie près de leur junction avec le corselet." Duftschmid, Paykul, and Scriba, described the color of the suture in the same manner.

Mr. Cornelius, Stett. Zeit., xxx, 408, discovered *A. pimpinellæ* in the nests of *Cypselus Apus* in immense numbers, so that he believes this to be its principal home. In one nest only one year old, he found one hundred and ten specimens. Regarding the description he says it is surprising that all the authors fail to record that the suture is red to the middle. He adds that probably specimens collected in the field may commonly lose the red scales which specimens developed before his eyes showed always very bright. Now the original description of Melsheimer says "only the suture on which is a common short linear spot behind the middle, and a similar but shorter one before the apex ochraceous," which agrees with the before quoted descriptions of *A. pimpinellæ*. Mr. Kuester describes *A. Isabellinus* from Spain, now recognized to be a variety of *Pimpinellæ*. In his description he mentions a character which is also to be found in *A. thoracicus*. Near the suture before the tip is a knotty, somewhat pointed tubercle, which is prolonged in a somewhat keel-shaped protuberance externally. As I stated, a number of *A. thoracicus* before me possess this character, which is perhaps a sexual difference, as in some of the specimens it is wanting. I do not see this character in other species of Anthrenus, but I confess I have not made an exhaustive study.

I would remark that the prothorax in *A. pimpinellæ* is more variegated than in *A. thoracicus*, but of the latter species my material is far from being sufficient. Some specimens agree with Dr. LeConte's description, the whole suture is fulvous, and some with Melsheimer's description. I think the characteristics of both species should be given again, if both are not climatic varieties. I do not know if the larva of *A. thoracicus* is known ; those of *A. pimpinellæ* before me, and as described by Cornelius, belong to the same type as *A. scrophulariæ.*

Of the other museum pests, *Ptinus fur* is very rare, and I have found this species only two or three times in the collection, probably imported with insects from Europe, where it is the most common and dangerous pest.

Besides these beetles, I made the acquaintance of a pest which I at first entirely underrated, namely, *Tribolium ferrugineum.* The species is cosmopolitan, and as I never heard of damage done by it, I did not at once give it much attention. It was imported several times with large collections of insects from the East Indies. The flat body of the larva, as well as of the beetle, make it particularly fit to enter boxes through the smallest crack. As the collections were exceedingly large, it was impossible to take care of them immediately in a thorough manner, and I observed an alarming increase of the insect. It was rather difficult to overcome, but I suceeeded by incessant care, partly by throwing away the worst infested insects, partly by killing individuals which I forced to come out of the body of specimens by filling the whole box with tobacco smoke. I saw the beetles and larvæ running out when the smoke began to fill the box, then I closed the box for an hour or two, when I found them all dead. With Tribolinus there was imported another cosmopolite, *Sylvanus surinamensis.* I was informed by Dr. LeConte that it is a beneficial insect and feeds upon Tribolium.

Westwood, in his Introduction, says that he has observed *Tribolium ferrugineum* infesting insects imported from East India. It is remarkable that this cosmopolite seems to assume injurious habits only there.

The most annoying pest I have had to do with in late years is the common clothes moth, *Tinea* (*Oecophora*) *flavifrontella.* I am not prepared to state if this species is certainly the *T. flavifrontella* of Europe, as I have no typical specimens before me, and confess to be somewhat in doubt about the determination. The name is used in the last edition of Harris, and by Dr. Packard, for this very common and injurious insect. I first made its acquaintance in the collection in the new work room, which was used before for storing skins of mammals and birds, and birds' nests, and of course harbored plenty of moths. As there are large cabinets attached to the wall, it was impossible to check their visits, which of course were chiefly limited to freshly collected or newly spread insects, where the boards were left uncovered. Now, every spreading board is fitted to go in a well closing box. Nevertheless it is somewhat inconvenient to be always sure that every box in the room is always well closed. The injury done by moths is always irreparable, as all parts are covered by spinning, and boxes once infested by moths I do not consider safe before several years have past. As the rooms are now entirely whitewashed, and, the doors kept closed, are without connection with the other rooms of the Museum, I hope to get rid of this pest in the future. How important it is to keep the doors of the insect rooms closed in a museum, I had the best proof three years ago. A large part of the collection was on the gallery in the second story, and the door of the lower room was always open. The next large hall was filled with stuffed animals and birds, both largely infested, and it was thought best to cure them with bicarbonate of sulphur. The consequence of this rather severe treatment with this dangerous explosive was that actually hosts of the moths indignantly emigrated through the next open door for pleasanter quarters, and fell at once upon all the cabinets opposite the door.

Several years ago I made experiments with this moth. I enclosed a certain number with rotten insects in a phial with glass stopper, where they propagated year after year. Three years later I remarked that the new generation was visibly smaller, and the sixth year most of the specimens were scarcely half as large as the common size of the moth. But among them I always observed a few, one or two, larger ones of the natural size. Of course I had added nothing to their food in all those years, so that the diminution of the size was probably lack of sufficient food.

Of other museum pests, two species of Psocus, *Atropus divinatorius* and *Clothilla pulsatoria*, are exceedingly rare in the collection, thanks to our boxes, which are not lined with paper. There is no doubt that these insects are very much attracted by paste or glue, and are never common therefore in prepared boxes. I think the injury done by them is mostly overrated, except where, as in England, insects on very short pins are placed in paper boxes. Here, delicate insects, Ephemerides, Psocidæ, Microlepidoptera, are destroyed. In the Museum they are so rare that several times when I wanted living specimens for study, I hunted without success through many boxes.

Once I found that freshly raised Bombycidæ were infested by them on the spreading board; now every spreading board is carefully cleaned, and the cracks washed with alcohol before it is used. After all I do not consider them dangerous in a well kept collection.

A species of Acarus, probably Tyroglyphus, was only once imported with a box of insects. I knew them very well as one of the most dangerous enemies, and at once prevented their increase. Of all the insects mentioned, I consider only *Attagenus megatoma* and *Anthrenus varius* and *scrophulariæ* as really dangerous pests. *Dermestes lardarius* cannot be at home in a well kept collection, and mostly appears by bad fortune, which sometimes happens in a large museum only. The entire separation of the entomological rooms from the rooms for the other animals, specially for mammals, birds and skeletons, can prevent their intrusion. This is always done in every large and well kept museum.

It is rather interesting to compare the museum pests in Europe with these data, which of course *apply only to the Museum of Comparative Zoology*, and I am not aware that other data about American museum pests are published.

D. lardarius is there as common as it is here, and too large to be easily overlooked, therefore not really dangerous. *Attagenus pellio* and *megatoma* are both common in countries, but in Europe *A. pellio* is a real pest, and very troublesome; here *A. megatoma* is exceedingly dangerous, though I never heard of injury done by it in Europe. The species of Anthrenus show a similar distribution. *A. museorum* and *A. varius* are both common in Europe, but only the first is a very important pest; the latter I never saw in collections, though it is here the most dangerous enemy. *A. scrophulariæ*, now very obnoxious here, is known as dangerous for woollen cloths and hides, or similar things, and is mentioned by Herbst in museums.

Tribolium, a very cosmopolitan insect, is nowhere recorded as a pest except in imported East Indian collections; and probably also in East India.

Concerning the moths I am not prepared for a definite statement. *T. flavifrontella* I do not find recorded as injurious in Europe, and I believe the moth destroying European collections is a different species, probably *O. sarcitella.* But I had then no special knowledge of the moth, and therefore I am not able to give a decided opinion.

A. divinatorius is here, as there, equally common. *Cl. pulsatoria* is probably not of any marked influence. But I believe that the young of *Psocus domesticus* sometimes do the harm attributed to *A. divinatorius.* At any rate dead imagos are not rarely found in boxes believed to be infested with *A. divinatorius*, therefore the latter is sometimes erroneously considered to be the previous stage of *Ps. domesticus.*

It would be rather interesting to compare the insect pests of other parts of the world with those observed here and in Europe. But the few scattered observations do not allow any comparison. The small house ants and white ants, where they exist, destroy everything. Fortunately I have no personal experience about them.

Concerning the best prevention against insect pests I may repeat again, I believe that having well closing boxes, and never putting additions into the collection before they are safe, are the only things to be done in a well kept collection. All other recommended remedies are only a poor help for bad boxes, and not needed if they are well made, and kept in good repair.

O. flavifrontella is described first by Schiffermueller, who says that the larva is unknown. Fabricius described it after the former type, and adds only in the second edition, "living in insect collections and feathers in Austria." *T. vestianella* L., which name was first accepted by Harris for the American moth, is an Oecophora, hardly determinable, as Prof. Zeller says.

Mr. Henry Edwards said that *Anthrenus museorum*, *A. varius* and Psocus were not common in California, but that there the real trouble in collections is with Acari. He had also found ants very troublesome in collections of fresh specimens at Panama and in New York.

Mr. E. P. Austin remarked that he had seen Tribolium common in one lot of insects. He had noticed that in Otiorhynchus as in the museum pests mentioned by Dr. Hagen, species common in Europe were rare here and *vice versa.* Thus *O. ligneus*[1] is common here, *O. sulcatus* rarer, while in Europe the opposite is true.

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[1] Since the above was printed some doubt has been thrown on this determination. — E. P. A.

General Meeting. November 6, 1878.

The President, Mr. T. T. Bouvé, in the chair. Twenty-two persons present.

In the absence of a quorum, the election of members was postponed.

The President briefly described the formation of "pot-holes" and introduced Mr. M. P. Kennard, who gave an account of the remarkable examples of this kind at Lucerne, Switzerland. These are among the largest pot-holes in the world, one measuring, according to the guide books, twenty-seven feet in diameter and eighteen feet in depth, the boulders at the bottom weighing many tons, and made of granite which is found in place, about fifty miles distant. Mr. Kennard showed and presented to the Society a monochrome picture of this group of pot-holes.

The thanks of the meeting was voted to Mr. Kennard for the communication and picture.

The following papers were read:

A CENTURY OF ORTHOPTERA. DECADE VIII. — ACRIDII (MELANOPLUS). BY SAMUEL H. SCUDDER.

71. **Melanoplus tenebrosus.** Of medium size. Head not elevated, moderately arched; eyes moderately prominent; vertex between the eyes about as broad as the length of the first antennal joint, the foveola rather shallow, but with distinct blunt bounding walls, which have a subovate outline; frontal ridge slightly compressed above, sulcate at the ocellus and below, laterally punctulate above. Pronotum pretty uniform, scarcely expanding on the posterior lobe, which is only slightly separated from the anterior lobe, the former obscurely punctate; median carina slight, distinct only at the extreme front and on the posterior lobe; lateral carinæ tolerably distinct; transverse sulci of anterior lobe slight, the anterior scarcely cutting the median carina. Tegmina a little longer than the body. Terminal ventral segment of ♂ abdomen scoop-shaped, subquadrate

and entire, supraanal plate rounded, triangular, of about equal length and breadth, the marginal apophyses of the preceding segment reduced to a pair of slight blunt tubercles; anal cerci small, compressed, the basal two-thirds straight, slightly tumid, directed backward, tapering slightly, the apical third forked, the forks at right angles, the upper twice as broad and half as long again as the lower, compressed, straight, but a little incurved, rounded at the tip; the lower more nearly in the course of the basal portion, straight, bluntly tipped; basal tooth of the lower valves of the ovipositor of the ♀ sharp, triangular, as long as broad.

The general color above is a very dark, almost blackish brown, the ♂ darker than the ♀, beneath dirty olive. The face is more or less purplish, the sides of the head flecked with yellowish green and with black; antennæ reddish at the base, becoming more and more fuscous apically; behind the eyes is a black band which crosses the upper margin of the lateral lobes of the prothorax, but from the general infuscation of the latter is not very distinct; the single female has a broad median belt of rust red on summit of head and prothorax, fading or becoming infuscated posteriorly. Tegmina very dark brown or blackish, especially in the ♂, with a few inconspicuous black flecks down the median area. Fore and middle femora reddish brown, infuscated above, especially at the apex; hind femora mostly blackish externally, with an oblique, more or less broken, median and basal band of dull testaceous in the males; knees black; hind tibiæ red, with a black or blackish, narrow basal annulus in the males, the spines black; the tarsal joints red, black tipped.

Length of body, ♂, 22 mm., ♀, 26 mm.; of antennæ, ♂, 10.5 mm., ♀, 9.5 mm.; of tegmina, ♂, 16.5 mm., ♀, 20.5 mm.; of hind femora, ♂, 13 mm., ♀, 14 mm. 2 ♂, 1 ♀. North Carolina, Morrison.

The species has the general aspect of *M. femur-rubrum* (Burm.), but from its forked cerci is more nearly allied to *M. collinus* Scudd., and to the species next described.

72. **Melanoplus arizonæ.** Of medium size. Head rather small, subcompressed, not elevated, moderately arched; eyes moderately prominent; vertex between the eyes as broad as the length of the basal antennal joint, the foveola very shallow, with moderately sharp, but not prominent, lateral walls, which give it a subspatulate form; frontal ridge rather broad, above slightly tumid, with punctulate sides, scarcely broader below, sulcate at the ocellus, and to some degree below it. Pronotum rather slender, rather uniform, but

distinctly broadening on the posterior lobe, which is separated from the anterior by a considerable depression and a pretty deep sulcus; posterior lobe rather distinctly punctate; median carina, though slight, distinct throughout; lateral carinæ obscure on the anterior lobe, the middle of the anterior half of the lateral lobes tumid just below their place; transverse sulci of anterior lobe distinct throughout, but not severing the median carina. Tegmina considerably longer than the body. Terminal ventral segment of ♂ abdomen scoop-shaped, rounded, entire; supraanal plate (so far as can be seen on the single specimen in which the parts are somewhat concealed) semi-ovate, broadly rounded apically, longer than broad; the marginal apophyses of the preceding segment slender, aculeate, parallel, approximate, about half as long as the supraanal plate; anal cerci moderate in size, compressed, the basal half tapering considerably, straight, directed backward, the apical half a little incurved, nearly equal, enlarging a little apically, and notched at the tip; basal tooth of lower valves of the ovipositor of the ♀ sharp, triangular, as long as broad.

The specimens on which this description is based were collected in alcohol, and little can be said of the colors; there is a more or less broken black band extending from the eye over the upper part of the lateral lobes as far as the posterior transverse sulcus; the hind femora may have been faintly banded, the hind tibiæ were probably red with black spines, and there is a distinct row of fuscous quadrate spots down the middle area of the tegmina, especially in the female.

Length of body, ♂, 21 mm., ♀, 22 mm.; of antennæ, ♂, 9 mm., ♀, 8 mm.; of tegmina, ♂, 19 mm., ♀, 19 mm.; of hind femora, ♂, 12.5 mm., ♀, 13.5 mm. 1 ♂, 1 ♀. Arizona. Through the kind communication of Prof. Cyrus Thomas.

This insect again has the general aspect and size of *M. femur-rubrum* (Burm.), but is more nearly allied to the species last described. In the peculiar termination of the anal cerci it somewhat resembles the group of heavy bodied Melanopli to which *M. femoratus* (Burm.) belongs, but there its special resemblance ceases.

73. Melanoplus infantilis. One of the smallest, if not the smallest, species known. Head rather large, but not elevated, and moderately arched. Eyes rather large, moderately prominent; vertex between the eyes scarcely broader than the first antennal joint (♂), or broader than the length of the same (♀); fastigium deeply and roundly (♂), or shallowly and flatly (♀), sulcate, the lateral edges blunt, and either slightly (♀) or distinctly (♂) divergent and then convergent anteriorly; frontal ridge broad, nearly equal, slightly larger below than above, tumid (♀) or flat (♂) above, with a row of punctæ on either side, narrowly and rather slightly sulcate at and just below the ocellus. Pronotum rather uniform, subequal, the posterior lobe broadening slightly, especially in the ♂, and subpunctate; the median carina distinct throughout, but much more slight on the anterior than on the posterior lobe; lateral carinæ tolerably distinct throughout, but blunt; transverse sulci of anterior lobe distinct throughout, unusually sinuous, not severing the median carina. Tegmina a little longer than the body. Terminal ventral segment of ♂ abdomen with its posterior margin elevated and notched; supraanal plate rounded triangular, the extreme apex excised, fully as broad as long, the marginal apophyses of the preceding segment reduced to a pair of minute and blunt triangular teeth; anal cerci thickened and tumid at base, immediately narrowing to half the width, almost immediately broadening again, curving inward while they run backward and upward, and forking, the upper branch directed upward and inward, nearly as large as the basal expansion, subtriangular, a little longer than broad, compressed and apically rounded; the other arm much longer, nearly as long as the rest of the appendage, slender, tapering, but bluntly pointed and directed backward and inward, a little arched from beneath; basal tooth of the lower valves of ovipositor of the ♀ large, triangular, sharp, as long as broad.

The general color is a dark griseous, the vertex of the head marked in black and dull yellow in a somewhat radiate fashion, the whole face and sides of head brownish olive or livid yellow, flecked more or less abundantly with black; the antennæ are pale dirty yellow, becoming infuscated toward the tip; behind the eye is a broad black band, often edged with yellow above, which also traverses the upper half or less of the anterior half of the deflected lobes of the pronotum, and is often enlivened by a small pale quadrate patch in the centre of the deflected lobes; the rest of the latter varies from yellow to brown, palest next the margins; the upper surface of the pronotum varies a good deal, but is usually griseous, often with a median belt of dirty yellow or ferruginous, edged on the front portion of the posterior lobe by a pair of oblique, crescentic, longitudinal or converging patches of black. Tegmina cinereous, with alternate minute blocks of yellow and blackish fuscous in the median area, apically changing to scattered square fuscous dots. Hind femora below straw yellow, above dark brown, with a pair of conspicuous, very oblique, pale bars at the middle and next the base; hind tibiæ pale glaucous, becoming paler next the base and straw yellow at the tip, the spines more or less heavily black tipped; hind tarsi yellowish.

Length of body, ♂, 13.5 mm., ♀, 16.5 mm.; of antennæ, ♂, 5 mm., ♀, 5 mm.; of tegmina, ♂, 11.5 mm., ♂, 11 mm.; of hind femora, ♂, 9 mm., ♀, 9 mm. 14 ♂, 22 ♀, mostly collected by myself, either in various parts of the South Park, Colorado, 8–10,000 ft. elevation, Aug. 11–16, or at Florissant, Colo., 8000 ft., Aug. 17–22, 1877. Others were taken in Colorado at an elevation of 5,500 ft. by Mr. Morrison, and at Evanston, Wyo. (6800 ft.), on Aug. 6, by myself.

This is a very interesting, lively and trim little species, which seems to be most nearly allied to *M. collinus* Scudd., but differs from all the species whose males have forked anal cerci, in that the lower branch of the fork is much the larger, and in having the last ventral segment notched, as in *M. spretus* (Uhl.).

74. **Melanoplus variolosus.** Of medium size. Head very slightly elevated, a very little arched; eyes rather prominent, squarely cut in front, the frontal ridge more than usually prominent; vertex between the eyes as broad (♂), or half as broad again (♀), as the first antennal joint; foveola rather shallow, particularly in the ♀, the sides in front of the eyes blunt, gently diverging and then converging, but in the ♀ subparallel; frontal ridge scarcely contracted above, scarcely enlarged at the ocellus, at and below which it is somewhat sulcate. Pronotum enlarging on the posterior lobe, laterally subtumid in an irregular way on the anterior lobe, the posterior lobe faintly punctate; median carina distinct on the posterior, faint (and posteriorly obsolete) on the anterior lobe; sides of the pronotum hardly shouldered, or with very rounded shoulders; transverse sulci of anterior lobe pretty distinct and continuous. Tegmina extending to, or a little beyond, the tip of the abdomen. Terminal segment of ♂ abdomen shallowly scoop-shaped, the edge entire, but just below it, at the extremity, a conical projecting tubercle; supraanal plate rounded triangular, pointed, fully as broad as long, the marginal apophyses of the preceding segment consisting of minute triangular denticles; anal cerci flabellate, consisting each of a very broad upturned lateral lamella, whose anterior edge is gently

convex, whose lower is strongly convex only at the expanded base, and there thickened, the tip rounded, angular, and the whole half as long again as the extreme width; basal tooth of the lower valve of the ovipositor of the ♀ sharp, triangular, nearly as long as broad.

The general color is a ferruginous brown above, mottled strongly with blackish fuscous, livid brown below; a blackish brown median stripe broadening posteriorly passes from between the eyes to the back of the head, but seldom continues, and then less deeply, upon the prothorax; the face and sides of the head vary from yellow to testaceous, and are seldom blotched by dusky colors, excepting on the cheeks; the antennæ, which are unusually long, are of a lighter or darker testaceous, and are scarcely infuscated at tip; a more or less broken black patch occupies the upper part of the anterior half of the deflected lobes of the prothorax. The tegmina are dark brownish cinereous, with a narrow median yellow stripe, frequently broken by quadrate fuscous or blackish spots, and similar blackish spots are scattered rather distantly all over the tegmina, giving them an unusually speckled appearance. Hind femora variable, either with oblique pale patches on a dark ground, or, and generally, the reverse; hind tibiæ glaucous, with black tipped spines; tarsi testaceous.

Length of body, ♂, 18 mm., ♀, 25 mm.; of antennæ, ♂, 9.5 mm., ♀, 10.25 mm.; of tegmina, ♂, 16 mm., ♀, 21 mm.; of hind femora, ♂, 11.5 mm., ♀, 14 mm. 3 ♂, 4 ♀. Lakin, Kansas (3000 ft.), Sept 1; Pueblo, Col. (4700 ft.), July, 8–9, Aug. 30–31. It was also taken by Mr. Morrison in Colorado at an elevation of about 5500 ft.

A peculiar species, somewhat related to *M. glaucipes* (Scudd.).

75. **Melanoplus flabellifer.** Of rather small size. Head scarcely elevated, well arched; eyes neither large nor very prominent; vertex between the eyes rather broader than the first joint of antennæ, the foveola pretty deep, faintly subspatulate, with abrupt but blunt bounding walls; frontal ridge slightly contracted above, and very slightly just below the ocellus; otherwise scarcely enlarging from above downward, scarcely depressed above the ocellus, strongly sulcate at and below the same. Pronotum rather simple, the posterior lobe expanding somewhat; the unequal halves of the anterior lobes each slightly tumid laterally, and as a whole, slightly expanding anteriorly; median carina nearly obsolete on the posterior portion of the anterior lobe, but otherwise nearly equal; transverse sulci of the anterior lobe pretty distinct, the posterior severing the median

carina; posterior lobe scarcely punctate. Tegmina a little longer than the body. Terminal segment of ♂ abdomen prow-shaped, straight, ending in a blunt conical projection; supraanal plate triangular, bluntly pointed, the sides a little convex, rather longer than broad, the marginal apophyses of the preceding segment forming distinct, pointed, triangular teeth. Anal cerci large, flabellate, upturned, twice as long as the mean breadth, tapering but little, the extremity broadly rounded.

The general color is cinereo-plumbeous, the head and prothorax dusky above, with the usual black belt behind the eye, extending over the anterior lobe of the prothorax; antennæ pale castaneous, paler at base; tegmina with a line of faint fuscous blotches in the middle field; hind femora livid brown on the outer face, heavily marked with rufo-fuscous in oblique bands, orange beneath; hind tibiæ rather dark glaucous with black spines.

Length of body, 16.5 mm.; of antennæ, 7.2 mm.; of tegmina, 13.75 mm.; of hind femora, 9.5 mm. 1 ♂, South Park, Col. (8–10,000 ft.), taken Aug. 11 and 16.

In all its structural features, this species closely resembles the preceding, of which it may be considered as a subalpine representative. It is, however, much smaller and its general appearance is very different, wholly lacking the mottled markings of that species.

76. Melanoplus fœdus. Of medium, or rather large size. Head rather large, not elevated, slightly arched. Eyes pretty large but not prominent; vertex between the eyes as broad (♂) or half as broad again (♀) as the first antennal joint; foveola shallow (♀) or moderate (♂), with low, stout, nearly parallel bounding walls, and scarcely expanding in front; frontal ridge stout, well advanced, subequal, scarcely enlarging downward, above flat at the ocellus, and below a little and broadly sulcate. Pronotum simple, the posterior lobe coarsely and faintly punctate, expanding very slightly, and, on either side anteriorly, depressed a little above; the anterior lobe narrowed a little in front, but above only, both the transverse sulci equally distinct and continuous throughout, median carina slight and confined to the posterior lobe, lateral carinæ subobsolete. Tegmina extending a little (♀), or considerably (♂), beyond the tip of the abdomen. Terminal ventral segment of ♂ abdomen scoop-shaped, but slightly produced at the apex, the edge entire; supraanal plate triangular, bluntly pointed, considerably longer than broad, the sides nearly straight, slightly puckered in the middle; the marginal apophyses of the preceding segment consist of wavy, depressed, conical, pointed projections diverging at nearly right angles, about half as long as the cerci. Anal cerci forming very simple compressed laminæ, the basal three-fifths straight, tapering a little and directed backward and a little upward, the apical two-fifths also straight, enlarging slightly, keeping the same direction but bent a little inward, the outer surface a little concave, the extremity squarely docked, its corners rounded; basal tooth of the lower valves of the ovipositor of the ♀ sharp, triangular, but much broader than long.

The general color is a dirty cinereous above, a dingy clay yellow below; antennæ dull testaceous, becoming somewhat ferruginous toward the tip; a pretty broad and usually distinct blackish brown or piceous band extends from behind the eye along the upper border of the deflected lobes as far as the posterior sulcus, and sometimes as a blurred and expanded continuation of it, across the posterior lobe also. Tegmina brownish cinereous, the anal field sometimes a little lighter, the median field enlivened to a greater or less extent, but seldom conspicuously, by an alternation of blackish and pallid longitudinal quadrate spots. Hind femora dirty clay brown with dusky incisures, above with a median and subapical dusky or dark fuscous patch; hind tibiæ red, with black tipped spines.

Length of body, ♂, 24 mm., ♀, 30 mm.; of antennæ, ♂, 13.5 mm., ♀, 12 mm.; of tegmina, ♂, 21 mm., ♀, 24 mm.; of hind femora, ♂, 14 mm., ♀, 16.5 mm. 12 ♂, 11 ♀. Pueblo, Colorado, Aug. 30–31. Taken in abundance in the river bottom, by Mr. Bowditch and myself.

This insect is closely related to *M. Packardii* Scudd., but by its dingy coloring presents a very different appearance.

77. **Melanoplus curtus.** Of rather small size. Head of moderate size, not elevated, moderately arched. Eyes rather small, somewhat prominent in the ♂. Vertex between the eyes as broad (♂), or nearly half as broad again (♀), as the first antennal joint; foveola shallow, with distinct and abrupt, but rounded bounding walls, which diverge a very little in front of the eyes and then converge; frontal carina scarcely contracted above, where its face is either flat (♂) or slightly tumid (♀), at and below the ocellus rather narrowly sulcate, deeper in the ♂ than in the ♀; antennæ longer than usual. Pronotum simple, the posterior lobe scarcely expanding, minutely rugulose; median carina distinct only on the posterior lobe and at the anterior extremity of the anterior lobe; elsewhere

obsolete, or subobsolete; transverse sulci of anterior lobe equally distinct and generally continuous, or broken only at the median carina; lateral carinæ distinct on the posterior half of the prothorax. Tegmina abbreviated, about two-thirds as long as the abdomen. Terminal ventral segment of ♂ abdomen scoop-shaped, the extremity a little produced and elevated, entire; supraanal plate shaped as in *M. fœdus*, the marginal apophyses of the preceding segment consisting of a pair of minute, parallel, distant, tubercular teeth, twice as long as broad. Anal cerci simple, straight and subequal, being contracted a little in the middle, nearly four times as long as the mean breadth, directed upward and backward, and the apical upper third incurved and externally tumid, the tip broadly rounded; basal tooth of lower valves of ♀ ovipositor sharp, prominent, triangular, but much longer than broad.

The general color is fusco-plumbeous above, dark clay yellow below; face and cheeks dull plumbeous, flecked with griseous, the top of the head dusky, and behind the eyes a piceous band extending over the upper part of the deflected lobes to the posterior sulcus, and sometimes, as a fuscous cloud, beyond it; antennæ ferruginous, yellowish toward base, dusky toward tip. Tegmina tapering, the middle line scarcely marked by faint paler and darker flecks. Hind femora blackish externally, with broad angulated patches of dirty clay yellow; beneath pale reddish, and at tip black; hind tibiæ red, with a greenish base, mostly obscured by a black or fuscous annulus, and armed with black spines.

Length of body, ♂, 18 mm., ♀, 23 mm.; of antennæ, ♂, 9.5 mm., ♀ 9.5 mm.; of tegmina, ♂, 10 mm., ♀, 11.5 mm.; of hind femora, ♂, 10.75 mm., ♀, 12 mm. 1 ♂, 1 ♀. Colorado (5500 ft.). H. K. Morrison.

This Melanoplus belongs to the same group as the preceding, and approaches most closely in character *M. rectus* Scudd., a rare New England species.

78. **Melanoplus interior.** Of medium size. Head not elevated, scarcely arched; eyes moderately prominent; vertex between the eyes rather broader than (♂) or nearly twice as broad as (♀) the first antennal joint; foveola exceedingly shallow and inconspicuous; frontal ridge subequal, flat above, depressed at the ocellus, but scarcely sulcate. Pronotum simple, the dorsal field broadening, though only slightly, throughout, the posterior lobe subrugulato-punctate, the median carina distinct throughout, the lateral carinæ

fading at anterior extremity; transverse sulci of anterior lobe equally distinct, both parted at the median carina. Tegmina extending beyond, or sometimes in the ♀ only to, the extremity of the abdomen. Terminal segment of ♂ abdomen broad scoop-shaped, the posterior edge a little lowered, entire; supraanal plate broad ovate, with parallel sides and rounded tip, more than half as long again as broad; the marginal apophyses of the preceding segment forming a fork with long, straight, slender, scarcely tapering, bluntly pointed, parallel arms, half as long as the supraanal plate; anal cerci rather broad and a little tumid at base, tapering at first very rapidly, especially above, then gradually, forming a subequal, slender blade which is directed backward and upward and curves inward, docked a little obliquely at the tip; basal tooth of lower valves of ♀ ovipositor with a sharp triangular tooth as high as broad.

In general color and in its variations this insect resembles *M. femur-rubrum* (Burm.). The antennæ are reddish, more or less infuscated toward tip; the upper portion of the sides of the anterior lobe of the prothorax has a broad piceous band which generally extends onto the head; the tegmina are brownish cinereous but vary greatly in markings, some being almost immaculate or showing only faint dusky flecks in the central field, others being conspicuously marked along the middle line by black dots on a clay-yellow ground and besides furnished with fuscous flecks all over the wing; others again are sprinkled with blackish dots throughout. The hind femora are usually darker above than below, with dusky interstices and indications, above, of oblique blackish bands more or less distinct. Hind tibiæ uniform red with black spines.

Length of body, ♂, 18.5 mm., ♀, 22.5 mm.; of antennæ, ♂, 8.5 mm., ♀, 8.5 mm.; of tegmina, ♂, 16 mm., ♀, 16 mm.; of hind femora, ♂, 11.25 mm., ♀, 13 mm. 9 ♂, 6 ♀. I found this species in the vicinity of Salt Lake City, Utah (4300 ft.), Aug. 1–4. It was also taken by Dr. E. Palmer, about the Wahsatch Mts. near Beaver, Utah, July 12–18, and at Spring Lake Villa, Utah Co., Utah, Aug. 1–4; also by Dr. Palmer at Fort Whipple in Arizona, and by Mr. Robert Ridgway, in Ruby Valley, Nev.

It is closely allied to our common eastern *M. femur-rubrum*, but appears to live beside it in the great interior basin of the continent.

79. **Melanoplus Bowditchi.** Of medium size. Head slightly elevated, moderately arched. Eyes rather large, pretty prominent, especially in the ♂; vertex between the eyes about half as

broad again as the first antennal joint, a little broader in the ♀ than in the ♂; foveola rather shallowly sulcate, subspatulate in form, the bounding walls thick and low; frontal ridge very equal, flat above, gently sulcate at and below the ocellus. Pronotum simple, the posterior lobe slightly expanding, punctulate, the median carina slight but distinct upon it, but wholly wanting in front; lateral carinæ obsolete; transverse sulci of anterior lobe distinct, subcontinuous across the middle. Tegmina very slender, extending beyond (♂) or fully to (♀) the tip of the abdomen. Terminal ventral segment of ♂ abdomen elongated scoop-shaped, the extremity a little produced, entire; supraanal plate subquadrate, longer than broad, the sides subparallel on basal half, beyond tapering rapidly, the tip triangularly produced, sharply angulated; marginal apophyses of preceding segment stout, depressed, attingent at base, beyond with inner margins separated at an angle of 45°, the outer margins straight and parallel, the extremity obliquely docked and scarcely incurved, each more than half the length of the supraanal plate and nearly three times as long as basal breadth; anal cerci formed on either side of a long, slender, straight, compressed finger much expanded above at the extreme base, scarcely tapering, bluntly and roundly terminated, directed backward, somewhat upward, and a little inward, and about as long as the first hind tarsal joint; basal tooth of lower valve of ♀ ovipositor blunt, triangular, large, broader than long.

The general color is a greyish brown, the eyes margined with dull pale yellow above, the face and cheeks olivaceous with transverse mottlings of dusky ferruginous; antennæ dull pale castaneous; behind the eye a broad piceous belt, sometimes broken, sometimes entire, crosses the anterior lobe of the prothorax on the upper half of the deflected side; the upper surface of the prothorax is brownish yellow, heavily punctate or mottled with fuscous. Tegmina with an obscure median row of alternate dusky and pallid spots; hind femora brownish-yellow, more or less tinged with plumbeous, the interstices dusky, with faint indications of dusky transverse stripes above; hind tibiæ bluish-green, sometimes dotted with black and with black spines.

Length of body, ♂, 23 mm., ♀, 26 mm.; of antennæ, ♂, 10 mm., ♀ —; of tegmina, ♂, 20 mm., ♀, 20 mm.; of hind femora, ♂, 13 mm., ♀, 14 mm. 1 ♂, 1 ♀. Pueblo, Col. (4700 ft.), Aug. 30–31; collected in company with my friend Mr. F. C. Bowditch.

I only met with a single pair of this species and have never received it from others; although belonging in the group with *M. femur-rubrum* (Burm.) it differs considerably from any other, the female bearing a resemblance to *M. collinus* Scudd.

80. Melanoplus flavidus. Moderately large in size. Head rather large, slightly elevated and well arched; eyes pretty large but not prominent; vertex between the eyes nearly (♂) or quite (♀) half as broad again as the first antennal joint; foveola subobsolete (♀), or shallow, broad, subequal, the sides moderately narrow but low (♂); frontal ridge broad, equal, above flat (♂) or tumid (♀), at and below the ocellus broadly and rather deeply sulcate. Pronotum simple, the anterior lobe equal, the posterior expanding and punctato-rugulose; median carina slight but distinct on the posterior lobe, obsolete or subobsolete in front of it; lateral carinæ subobsolete; transverse sulci of anterior lobe slight but distinct, continuous. Tegmina extending a very little way beyond the abdomen. Terminal ventral segment of ♂ abdomen scoop-shaped, well rounded, the tip scarcely produced, entire; supraanal plate regularly shield-shaped, about as broad as long; the terminal apophyses of the preceding segment shaped much as in *M. Bowditchi* but thickened at the tip, as long as the cerci or nearly two-thirds as long as the supraanal plate; the anal cerci have a triangular base and a long, straight, slender, bluntly terminated, equal finger extending backward and upward, and inclined inward, starting from the lower posterior portion of the base; it is as long as the terminal joint of the hind tarsi; basal tooth of the lower valve of the ovipositor of the ♀ small, triangular, sharp, broader than long, preceded by a smaller one.

The general color is greenish yellow, sometimes a little infuscated above; the head is frequently mottled with fuscous; the antennæ are uniform yellowish; the usual stripe behind the eye over the sides of the pronotum is generally reduced to a very narrow dusky stripe next or on the lateral carinæ, diminishing in size posteriorly; or if it is broader, it invades the superior surface and not the deflected lobes; the upper surface of the prothorax has a median, dusky line and the summit of the head a dusky basal triangle. The tegmina partake of the general lively tone to a less extent, and the paler median stripe, distinct only at base, is seldom flecked intermittently with fuscous. Hind femora yellow, the upper half of the outer face dusky, and two oblique dusky patches often occur in the usual place above; hind tibiæ glaucous, the spines white or glaucous, black tipped.

Length of body, ♂, 26 mm., ♀, 27 mm.; of antennæ, ♂, 13 mm., ♀, 9.75 mm.; of tegmina, ♂, 20.5 mm., ♀, 22 mm.; of hind femora, ♂, 14 mm., ♀, 15 mm. 2 ♂, 2 ♀, taken at Mr. Lake's camp at Morrison, Col., Aug. 9.

This species resembles *M. Packardii* Scudd. in general appearance but belongs to the group of *M. femur-rubrum* (Burm.) being closely allied to the last described species, from which it differs greatly in coloration.

A CENTURY OF ORTHOPTERA. DECADE IX. — ACRIDII (PEZOTETTIX). BY SAMUEL H. SCUDDER.

81. Pezotettix variegatus. This species is so closely allied to the well-known *P. pictus* Thom. and therefore so distinct from all other American species of this group, that it is best described by comparison with that species. This is particularly the case, because it is known to me only by specimens which have lost their original colors by immersion in alcohol. Judging however by comparison with similar specimens of *P. pictus* it would appear that this new species differs from it in having a less vivid variegation, and less contrasted coloration. No doubt when fresh specimens are examined, many distinctions in colorational features may be laid down. The most noticeable differences in other directions are: — the heavier punctuation of the posterior lobe of the pronotum in *P. variegatus* (which lobe is also slightly longer, being more produced posteriorly), the much more broadly oval tegmina (which are twice as long as broad in *P. pictus* and only once and a half times in *P. variegatus*, the length being the same in each), the rather stouter hind femora, the less pointed anal cerci, and the slightly larger development of the small marginal apophyses of the last dorsal segment of the ♂ abdomen. It is of the same size as *P. pictus*. 2 ♂, 13 ♀.

This species is interesting as occurring only on the western side of the continental divide, while *P. pictus* is confined to the eastern side. I think Mr. Thomas somewhere makes this latter statement, but I can only find the tabular reference in his Acrididæ of N. America, which states that it belongs to the southern Rocky Mt. region. It is common in Texas, I have taken it at Cucharas in Southern Colorado, but it did not occur in Garland, across the Sangre de Cristo Mts. I also took it on the eastern slope of the divide at the Argentine Pass at an elevation of 12,000 ft. or more; it is abundant on the plains all along the eastern base of the Rocky Mts. in Colorado, and did not occur about Green River City in Wyoming Territory. But it also extends farther north than Mr. Thomas indicates in the place above referred to, for I have specimens taken by Mr. E. P. Austin on the southern Black Hills; by some of the R. R. Surveys between Ft. Union and Ft. Benton on the upper Missouri; and by Gen. Sully in his explorations in Dacota, at what precise point is not indicated. *P. variegatus* on the other hand has been taken at San Diego, California, by Dr. Edward Palmer, in Sonora by Mr. Schott, during the exploration of the Mexican Boundary Survey; and in Southern Arizona by Dr. Palmer, at Fts. Whipple and Buchanan and at a point forty miles east of Tucson. This is the first instance recorded of the occurrence of this group of Pezotettix upon the western side of the Rocky Mts.

82. **Pezotettix dumicolus.** Vertex between the eyes very narrow, scarcely equalling the width of the first antennal joint; foveola shallow, slender, subspatulate, with rather coarse bounding walls; frontal ridge moderate, equal, excepting in being very slightly and roundly contracted at the summit, sulcate at the ocellus and below it. Prothorax very simple, uniformly and slightly expanding posteriorly, the front border straight or scarcely convex, the hind border slightly and broadly emarginate in the middle; the lateral carinæ completely obsolete and uniform, the disc passing imperceptibly into the deflected lobes; the median carina faint, very blunt, equal throughout; the anterior lobe is sparsely and rather faintly punctate, the posterior more distinctly and abundantly, but with minuter punctæ. Tegmina lateral, minute, considerably shorter than the prothorax, bluntly rounded at tip, the inner margin nearly straight, the costal very convex, the whole twice as long as the extreme breadth. Last ventral segment of ♂ abdomen quadrate, tumid, the upper (posterior) edge semicircular, entire, and projecting over it a backward directed, stout, sub-depressed, blunt process, taking the place of the membrane which usually covers the semicircle in Pezotettigi; supraanal plate triangular, a very little longer than broad, the sides nearly straight, the extreme tip blunt; the marginal apophyses of the preceding segment reduced to a broad lamellate triangular tooth, its angle projecting but little at the middle of either half of the supraanal plate; anal cerci broad, compressed-laminate, subequal but somewhat and broadly constricted in the middle, straight and directed upward, the apical half also curved inward, the apex excised,

broadly rounded and produced a little above (or in its position, anteriorly).

The general color is dark umber above, yellowish testaceous below; face dull olivaceous, in the ♀ apparently darker by infuscation; antennæ testaceous, more or less infuscated on the apical half; on the back of the head a clay-colored band, which partly encircles the eye above, extends backward over the pronotum on which it is very slightly arched; a similar but much broader and rather paler belt borders the lower margin of the deflected lobes, while a median line of the same color occurs on the abdomen, a mere line in front, broadening as it passes backward, extending over the whole dorsum and apically confluent with the lighter color of the under surface, leaving on either side between the upper and lower surfaces a broad but narrowing black belt. Hind femora with the outer face dark green, more or less infuscated, sometimes nearly black especially on the upper half, the upper ferruginous and the lower greenish yellow; hind tibiæ rather dull green, occasionally obscured at either extremity, the spines with apical half black.

Length of body, ♂, 14 mm., ♀, 18.5 mm.; of antennæ, ♂, 7.25 mm., ♀, 7 mm.; of tegmina, ♂, 2.8 mm., ♀, 3 mm.; of hind femora, ♂, 9 mm., ♀, 10.5 mm. 2 ♂, 4 ♀, taken in Bosque Co., Texas, in woods on plants and bushes in the latter half of September and the former half of October. Pairs were taken October 11th. This species bears a general resemblance to *P. gracilis* Bruner, with which *P. minutipennis* Thom. is synonymous.

83. **Pezotettix nudus.** Eyes rather small; vertex between them as broad as (♂), or rather broader than (♀) the first antennal joint; foveola very shallow and inconspicuous, very slender, spatulate in form; frontal ridge moderate, equal, flat above, at and below and to some extent a short distance above the ocellus sulcate. Pronotum very simple, expanding a very little posteriorly, mostly on the poserior half, the front and hind margins straight, the latter sometimes almost imperceptibly emarginate in the middle, especially in the ♂, the lateral carinæ wholly wanting; the median carina very slight, but distinct, and equal throughout; the whole pronotum is equally subrugoso-punctuate throughout, unless it be that the disc is coarser than the deflected lobes; meso- and metanotum, and the basal segments of the abdomen similarly but more obscurely punctured, Not a vestige of tegmina. Terminal ventral segment of ♂ abdomen twice as broad as long, tumid, the upper edge a little and

angularly produced in the middle; supraanal plate nearly square, tapering very slightly, the outer angles slightly produced, and the posterior edge with a median triangular pointed extension, a third as wide as the extremity of the plate, and longer than broad; marginal apophyses of preceding segment consisting of a pair of attingent, depressed, rather stout, scarcely tapering, blunt-tipped fingers, fully half as long as the plate, and slightly upturned at the tip; anal cerci very simple, being slight conical projections, tapering mostly in their basal half, the tip blunt, the whole not so long as the disc of the supraanal plate.

The general color is a greenish yellow, more or less tinged with brown, brighter in the ♂ than in the ♀, and marked with blackish fuscous; the darker markings consist principally of a dorsal stripe, which either extends over the pronotum as a broad equal band, often fainter in the middle, with a triangular extension on the head, and sometimes a narrowing infuscation on the meso- and metathorax (♂), or forms an obovate patch along the middle of the anterior lobe of the prothorax, with the same triangular extension on the head, and reappears sometimes on the meso- and metathorax, and always on the abdominal joints, as a series of obliquely descending, triangular, lateral patches, separated from one another by a yellowish median line (♀); also of a broad lateral band, which extends from behind the eye backward, either to the hinder edge of the prothorax, its upper margin straight, its lower curved (♂), or across the anterior lobe of the prothorax (occasionally in an obscure manner across the entire prothorax), both margins curved (♀); beyond this the lateral band extends over the remainder of the thorax, and over the abdomen, often broken on the latter into spots, and always enlivened on the former by an oblique yellowish line, which crosses it on the metathoracic episterna. The face partakes of the color of the under surface, as do the bases of the antennæ; beyond the antennæ become slightly rufous; the vertex just behind its narrowest point has a transverse blackish line. Hind femora greenish yellow, the lower portion of their outer face more or less embrowned, deepening frequently into black, which occasionally covers the whole; hind tibiæ pale green, the spines black tipped.

Length of body, ♂, 16.5 mm., ♀, 23 mm.; of antennæ, ♂, 8 mm., ♀, 8 mm.; of hind femora, ♂, 10 mm., ♀, 12.25 mm. 4 ♂, 12 ♀. Dallas, Texas. J. Boll.

This is the only absolutely apterous species of Pezotettix I know, which occurs at low elevations. All others, I believe, are sub-alpine.

84. Pezotettix lakinus. Vertex between the rather small eyes half as broad again as the basal antennal joints; foveola broad, shallow, flat, expanded in front, the bounding walls low and thick; frontal ridge moderate, slightly expanded at the ocellus, sulcate almost throughout, the summit only flat. Pronotum unusually short, especially in the ♀, but simple, scarcely expanding posteriorly, either half of the deflected portion of the anterior lobe slightly tumid above in the ♂; front margin straight; hind border very little angulated and rounded; median carina slight but distinct, equal; lateral carinæ well marked, forming a nearly square shoulder, especially on the hinder portion of the anterior lobe. Tegmina lanceolate, sharply pointed, longer than the pronotum, fully twice as long as broad, their inner and costal margins about equally convex. Last ventral segment of the ♂ abdomen conical, strongly upturned, about as high as broad, the extreme posterior edge produced to form a rather large, rounded elevation, nearly as high as broad; supraanal plate triangular, as long as broad, the sides nearly straight, the tip rounded; marginal apophyses of the preceding segment rather distant, broad at base, with a slight median, tapering, pointed projection, the whole process very small; anal cerci very tumid, spherico-triangular at base, carinate on the posterior outer margin, with a slight, equal, slender and blunt-tipped finger, shorter than the base, extending inward and upward from the upper angle of the basal swelling.

The general color is a brownish griseous, tinged below with yellowish; the antennæ are dark, and sometimes darker apically. Along the top of the head and pronotum is a blackish fuscous, rather broad median stripe, sometimes broadening in patches, sometimes obsolete; the upper half of the deflected portion of the anterior lobe of the pronotum is marked by a broad, blackish fuscous belt, which is often separated from the front margin and the frequent extension of the band to the eye by a narrow yellow line. The tegmina are uniformly griseous, with a median slender line of alternate yellowish and fuscous flecks, often obsolete. The hind femora are lighter or darker testaceous, with two very broad, oblique, blackish belts, which do not reach the pale orange under surface; hind tibiæ dull glaucous, the spines pale at base, black tipped; sides of the abdomen marked with black at base.

Length of body, ♂, 22 mm., ♀, 30 mm.; of antennæ, ♂, 9 mm., ♀, 9.5 mm.; of tegmina, ♂, 7 mm., ♀, 7 mm.; of hind femora, ♂, 12.5 mm., ♀, 14 mm. 3 ♂, 4 ♀. Taken at Lakin, Kansas (3000 ft.), Sept. 1, and Pueblo, Col. (4700 ft.), Aug. 30–31, by myself; and in Colorado 5500 ft., by Mr. Morrison.

This remarkable species is very distinct from any yet described, though I have an allied but still very different form from Sonora.

85. **Pezotettix texanus.** Vertex between the eyes half as broad again (♂), or twice as broad (♀), as the first antennal joint; the foveola exceedingly shallow, hardly perceptible, broad, enlarging apically, well rounded apically; frontal costa moderate, rather prominent, equal, flat; sulcate nowhere, excepting immediately beneath the ocellus, and there but slightly and briefly. Pronotum very simple, nearly equal, enlarging a little on the posterior lobe (♂), or enlarging posteriorly to a considerable extent, and uniformly throughout (♀), the front margin scarcely convex (♂) or straight (♀), the hind border very broadly angulate, the median carina distinct and abrupt, but slight and equal, the lateral carinæ subobsolete; the posterior lobe very faintly rugulose. Tegmina produced ovate, about as long as the head and prothorax, nearly twice as long as broad, the inner margin rather gently, the costal margin considerably convex, the tip roundly pointed. Last ventral segment of ♂ abdomen pyramidal, the open top quadrate, facing forward, the posterior edge a little produced and entire; supraanal plate triangular, a very little broader than long, pointed, the sides nearly straight; the marginal apophyses of the preceding segment consisting of slight but broad, depressed, angular teeth, their points as far apart as the width of one of the apophyses; anal cerci pretty broad and straight, broadly and roundly contracted in the middle, the extremity docked and rounded, the whole directed toward the apex of the abdomen, and curved considerably inward.

The general color is a dull somewhat cinereous brown above, a dirty but rather pale greenish brown below, marked conspicuously by a very broad, straight, piceous belt, scarcely larger behind than in front, extending from the eye across the anterior lobe of the pronotum, its upper edge at the lateral carinæ; the antennæ are pale red, infuscated apically. The upper surface of the body and the tegmina are more or less profusely dotted with very pale fuscous; an oblique wedge-shaped, yellow dash, the apex in front and above, follows the ridge of the metathoracic episterna, margined on either side by an equal piceous belt. The hind femora generally partake of the color of the upper surface of the body, but appear darker from being speckled with blackish fuscous dots, which generally cluster more or less into two very oblique bands in the middle and beyond the middle, and also margin interruptedly the upper outer carina; hind tibiæ red, the apical half of the spines black.

Length of body, ♂, 23.5 mm., ♀, 31 mm.; of antennæ, ♂, 10 mm., ♀, 11 mm.; of tegmina, ♂, 7.6 mm., ♀, 10 mm.; of hind femora, ♂ 14 mm., ♀, 17 mm. 6 ♂, 8 ♀. Dallas, Texas, J. Boll. No. 55.

86. Pezotettix discolor. Vertex between the eyes half as broad again as the basal antennal joint (♂ ♀), the foveola shallow, indistinct, broad, enlarging apically; frontal ridge broad, equal, flat (♂) or slightly tumid (♀) above, sulcate below. Pronotum simple, scarcely enlarging on the posterior lobe, front border straight, hind border roundly and broadly angulated; median carina distinct though rather slight, equal; lateral carinæ scarcely perceptible; posterior lobe of pronotum faintly punctate. Tegmina tapering, a little longer than head and prothorax together; the anterior and posterior fields separated by an angle. Last ventral segment of ♂ abdomen conical, longer than broad, the tip compressed; supraanal plate triangular, longer than broad, pointed, the sides straight; marginal apophyses of the preceding segment consisting of a pair of approximated, small, triangular teeth, the tip a little produced; anal cerci forming on each side a broad semicircular rounded flap, the upper side concave, the lower convex, the tip rounded, the whole in one plane.

The general color is a yellowish or cinereous brown above, a paler brownish yellow below, marked on the sides of the head, prothorax and pleura as in *P. texanus*. The antennæ are pale red, infuscated apically. The superior field of the tegmina is of the same color as the disc of the pronotum, or occasionally a little paler, while the deflected field is nearly always much darker brown, the middle field marked by dashes of blackish fuscous which occasionally suffuses nearly the whole of the deflected portion. The hind femora are twice barred with blackish above, and have more or less blackish fuscous on their outer face; while the under portion of the femora is yellowish and the hind tibiæ red with black-tipped spines.

Length of body, ♂, 19 mm., ♀, 25 mm.; of antennæ, ♂, 9 mm., ♀, 8.5 mm.; of tegmina, ♂, 8 mm., ♀, 9.5 mm.; of hind femora, ♂, 12 mm., ♀, 13.5 mm. 4 ♂, 12 ♀. Dallas, Texas, J. Boll. No. 56.

This species closely resembles *P. texanus* in general coloration, but is markedly distinct from it in the form and structure of the tegmina. The abdomen of the ♀ is more than usually compressed.

87. **Pezotettix flabellatus.** Vertex between the eyes nearly half as broad again as the first antennal joint; the foveola shallow, broad, subspatulate, with distinct but low and coarse bounding walls; frontal ridge broad, equal, flat throughout, or faintly sulcate down the middle below the ocellus. Pronotum very simple, enlarging backwards uniformly but slightly, and less so in the ♂ than the ♀; front margin straight, hind margin gently angulato-arcuate; the median carina distinct, slight, equal; the lateral carinæ scarcely indicated, and on the posterior lobe wholly obsolete; whole disk gently punctate, the anterior lobe more sparsely than the posterior. Tegmina rounded ovate, a little shorter than the pronotum, half as long again as broad, the apex not at all produced, only slightly overlapping at their inner margins. Last ventral segment of the ♂ abdomen elevated, longer than broad, tapering a little, well rounded at apex, the posterior margin a very little produced, and minutely notched; supraanal plate triangular, of about equal length and breadth, the apex bluntly pointed, the sides very nearly straight, with a transverse median ridge not reaching the sides; marginal apophyses of the preceding segment formed of two rather distant, nearly straight, subconical processes, scarcely reaching the transverse ridge; anal cerci simple, conical, scarcely curved, tapering more on the basal than the apical half, about half as long as the supraanal plate.

The general color above is either a very pale brownish yellow, or a brownish griseous; below dirty yellow, with a greenish tinge; the antennæ are red, darker toward tip; a broad belt of blackish fuliginous runs from behind the eye across the prothorax, generally broadening slightly, and fading a little on the posterior lobe. The sides of the thorax are marked as in *P. texanus*, and the tegmina are unicolorous and of the color of the pronotum. The hind femora partake of the color of the upper surface of the body, and have faint fuscous indications of the double bar above; the hind tibiæ are glaucous, but at the base yellowish, with a glaucous, or glauco-fuscous annulus; the spines are black, with a pallid base. The upper surface and sides of the abdomen are uniform in tint, the sides unmarked by any black band.

Length of the body, ♂, 19 mm., ♀, 27 mm.; of antennæ, ♂, 7.75 mm., ♀, 8 mm.; of tegmina, ♂, 5 mm., ♀, 6 mm. ; of hind femora,

♂, 10.25 mm., ♀, 14 mm. 7 ♂, 25 ♀. Dallas, Texas, J. Boll. Nos. 51, 124.

In general appearance and in most points of its structure this species resembles *P. discolor*, described above. It may at once be distinguished from it by the form of the wings and anal cerci, and the color of the hind tibiæ.

88. **Pezotettix pupæformis.** Vertex between the eyes half as broad again (♂), or twice as broad (♀), as the first antennal joint; foveola broad, shallow, enlarging slightly in front, the bounding walls low and rounded; frontal ridge moderate, equal, flat, sunken a little at the ocellus, and, in the ♂, sulcate below it. Pronotum simple, equal, the front margin a very little full, the hind margin gently angulated; median carina distinct, though rather slight, equal; lateral carinæ rounded off; anterior lobe faintly and distantly, posterior lobe abundantly but not deeply punctate. Tegmina obovate, about as long as the pronotum, less than twice as long as broad, the curves of the inner and costal margins equal, the tip acutely angled. Last ventral segment of ♂ abdomen very short and broad, tumid, the centre with a small pointed tubercle, the posterior (upper) edge slightly elevated, entire; supraanal plate triangular, sharply pointed, fully as long as broad, the sides straight; marginal apophyses of preceding segment consisting of a pair of minute, rounded, approximated, flattened lobes, as long as broad; anal cerci with the basal half tapering by the rapid sloping of the upper edge, so as to be half as broad in the middle as at the base, beyond broadening again somewhat on the same side, so that the apical half is subspatulate, continuous with the basal part, but strongly incurved, deeply channeled externally, the tip broadly rounded, the whole about as long as the last joint of the fore tarsi.

The general color is a griseous brown, excepting the abdomen, which is brownish testaceous; beneath clay yellow; the antennæ are yellow at the base, deepening beyond to fuscous ferruginous; from behind the eye a broad black band extends to the posterior lobe of the pronotum, generally enlivened on the cheeks by an oblique yellow streak, which in the ♀ traverses narrowly the pronotum nearly or quite to the lateral carinæ; the tegmina are of the color of the disc of the pronotum, and immaculate. Hind femora clay yellow, more or less infuscated, and with a pair of often obscure blackish bars; hind tibiæ glaucous, pallid at base, with a blackish annulus.

Length of body, ♂, 21.5 mm., ♀, 23 mm.; of antennæ, ♂, 8.5 mm., ♀, 7.5 mm.; of tegmina, ♂, 6 mm., ♀, 6.5 mm.; of hind femora, ♂, 12.5 mm., ♀, 14 mm. 11 ♂, 13 ♀. Dallas, Texas, J. Boll.

This species resembles and is allied to *P. flabellatus*, described above.

89. Pezotettix aridus. Vertex between the eyes narrow, being rather less than the width of the first antennal joint; foveola sulcate, narrow, considerably expanding in front, the bounding walls stout, rounded; frontal ridge moderate, nearly equal, contracted slightly just below the ocellus, above flat, below the ocellus a little sulcate. Pronotum simple, expanding a very little posteriorly, the anterior lobe slightly swollen on the deflected lobes above; front margin straight, hind margin gently convex, subangulated; median carina distinct, equal, but low and rounded; lateral carinæ wholly obsolete, excepting on the front portion of the posterior lobe, where they are very slight; posterior lobe punctate; anterior lobe faintly and very distantly subpunctate. Tegmina rounded ovate, shorter than the pronotum, hardly more than half as long again as broad; costal and inner margins about equally convex, the extremity excised and broadly rounded, not in the least produced. Last ventral segment of the ♂ abdomen subpyramidal, broader than high, the extremity broadly rounded, but subcompressed, the apical edge not produced, entire; supraanal plate triangular, about equally long and broad, the sides nearly straight, the tip angulated; marginal apophyses of the preceding segment consisting of a pair of subapproximate, slight and equal fingers, bluntly tipped, hardly more than a quarter the length of the supraanal plate; anal cerci slender, compressed, slightly and very broadly concave on either side, directed backward and a little inward, the upper portion of the enlarged extremity produced considerably, and curved over still more inward, tapering and bluntly rounded at tip; the whole is considerably shorter than the supraanal plate.

The specimens before me have lost their colors from immersion in alcohol, but they were apparently light colored, probably more or less flavous, and for the most conspicuous markings have a broad, black band at the upper limit of the deflected lobes of the pronotum, which extends only faintly over the back of the head to the eye; this band either narrows on the posterior lobe, so as only to edge the lower side of the lateral carinæ, or, if of equal width with the preceding portion, is enlivened by a yellow stripe passing longitudinally through the middle, a continuation of the black-bordered yellowish stripe on the metathoracic epipleura; occasionally the band is wholly obsolete on the posterior lobe; in the middle of the portion of the band on the anterior lobe is also a roundish or oblique pyriform yellowish spot. Hind femora apparently yellowish, the incisures infuscated, with rather faint traces of a pair of broad, dusky bars above; hind tibiæ perhaps reddish in life, with black spines lighter colored at base.

Length of body, ♂, 17.5 mm., ♀, 21 mm.; of antennæ, ♂, 10.5 mm., ♀, 8.5 mm.; of tegmina, ♂, 4 mm., ♀, 4.5 mm.; of hind femora, ♂, 12.5 mm., ♀, 13 mm. 1 ♂, 4 ♀. Arizona and San Carlos (Ariz.?), Lt. Wheeler's explorations; Ft. Whipple, Ariz., and Ft. Buchanan, Southern Arizona, Dr. E. Palmer.

Mr. Thomas, judging from the types he has kindly sent me, has confounded two species in the insect he has described as *Pezotettix Humphreysi*, the ♂ and one of the ♀ ♀ belonging to the species above described, the other females to another, which apparently were principally used in his description, for he describes the tegmina as " mere figments on the sides . . . spatulate." I have accordingly restricted *P. Humphreysi* to the larger species, with tegmina more than twice as long as broad, very oblong oval, enlarging from the base outward, the inner (upper) edge nearly straight, the costal edge convex, the apex broadly rounded, and the tip neither produced nor excised; the veins of the tegmina are also less frequent than in *P. aridus*. I I have a specimen of the latter species collected by Xantus, perhaps at Cape St. Lucas, Lower California. *Pez. aridus* is somewhat nearly related to *Pez. pupæformis* Scudd.

90. Pezotettix aspirans. Vertex between the eyes considerably broader than the first antennal joint, rather broader in the ♀ than in the ♂; foveola shallowly sulcate, subequal, the bounding walls low and coarse; frontal ridge subequal, expanding at the base, very slightly sulcate above, more sulcate, but not deeply, below the ocellus. Pronotum very short and stout, simple, expanding a little on the posterior lobe; anterior and posterior lobes of equal length; front margin straight, hind margin gently angulated, more prominently in the ♀ than in the ♂; median carina distinct but dull and equal on the posterior lobe, absent from the anterior lobe; transverse sulci of the anterior lobe unusually distinct, continuous; lateral carinæ distinct but rounder; disc punctate, distantly and rather faintly on the anterior lobe, abundantly and rather coarsely, but still faintly, on the posterior lobe. Tegmina short subfusiform, scarcely longer than the pronotum, about twice as long as broad, the extremity produced but rounded, the inner edges not overlapping each other. Last ventral segment of the ♂ abdomen sharply upturned and tumid, short-conical, several times broader than high, the extremity just below the entire apical edge produced to a blunt point; supraanal plate triangular, perhaps a little longer than broad, the sides straight, the tip rounded, the surface subgibbose; marginal apophyses of the preceding segment forming minute, triangular, blunt, rather distant teeth; anal cerci simple, regularly conical, compressed at base, blunt tipped, considerably shorter than the supraanal plate.

The general color is blackish griseous, very obscurely mottled with testaceous above, dirty yellow, tinged with ferruginous below; antennæ pale red at base, much infuscated beyond; a quadrate piceous patch occupies the upper part of the anterior section of the deflected lobes, followed immediately below by a paler tint, and occasionally edged on the lateral carina with dull testaceous. Tegmina with some of the veins of the dorsal field (for the anterior field is deflected) testaceous. Hind femora testaceous, conspicuously marked with black at base and tip, and by two moderately broad transverse bands, the one just before the middle V-shaped; hind tibiæ pale red, marked with black toward the base, the spines black.

Length of body, ♂, 13 mm, ♀, 22 mm.; of antennæ, ♂, 4.5 mm., ♀, 6.25 mm.; of tegmina, ♂, 4.75 mm., ♀, 5.75 mm.; of hind femora, ♂, 8.25 mm., ♀, 10 mm. 1 ♂, 4 ♀. I took this species above timber on Pike's Peak, at an elevation of 12–13,000 ft., on Aug. 24. Mr. Morrison has also sent it to me from Colorado, marked as coming from an elevation of 13,000 ft.

This insect is interesting from its close relation to *Pezotettiz alpinus* var. *montanus* of Europe. It also bears a close general resemblance, but is not so closely allied, to *Pez. Marshallii* Thom., from high elevations in Southern Colorado. This latter species, as I have lately ascertained by examination of the type, courteously sent me by Mr. Thomas, is not the species I described under that name, doubtfully, in the Report of the Chief of Engineers for 1876, pp. 502–03. The species there described may receive the name of *Pez. altitudinum.*

A CENTURY OF ORTHOPTERA. DECADE X. — LOCUSTARIÆ (CONOCEPHALUS). BY SAMUEL H. SCUDDER.

91. Conocephalus hamatus. A stout species of moderate size, brown, the tegmina faintly flecked with fuscous dots, especially along the edges. Fastigium above flat, triangular, regularly tapering, pointed, advanced in front of the eyes as far as the narrowest space between the eyes, and like the rest of the summit of the head scabrous; the apex bent downward in the form of a minute, delicate, pointed hook; a similar, stouter, but delicate pendant to the lower base of the fastigium, the middle line between them carinate, either side flat and very scabrous. Pronotum scabrous, the disk scarcely enlarging posteriorly, the lateral lobes roundly deflected, giving the thorax a stout appearance. Tegmina tolerably broad, and nearly equal, the extremity obliquely docked, the inferior (inner) edge slightly upturned at tip, and rounded. Femora scabrous, the middle and hind pair and apical half of fore pair furnished beneath with pretty stout and not infrequent spines; hind legs very short, the tibiæ being less than half as long as the tegmina. Ovipositor comparatively short, not reaching so far back as the tegmina, and only slightly longer than the hind tibiæ.

Length of body, 33.5 mm.; of fastigium beyond front edge of eyes, 3 mm.; of pronotal disk, 8.75 mm.; of tegmina, 43 mm.; of hind tibiæ, 18 mm.; of ovipositor, 21.5 mm. 1 ♀. Guatemala, Van Patten.

This species closely resembles *C. uncinatus* Harr., but has a shorter fastigium.

92. Conocephalus aduncus. A small and slender species, green or brown, the tegmina sometimes with a very few distant fuscous dots. Fastigium of moderate size, arched above the plane of the head, the surface slightly flattened, and a little scabrous, enlarged a little beyond the base, and beyond the tumescence tapering rapidly, the extremity produced into a minute, pointed, decurved, glistening, castaneous hook; the base of the fastigium below is armed as in *C. hamatus*, but lacks the median carina; the length of the fastigium beyond the front of the flattened eyes is scarcely more than equal to the narrowest space between them. Pronotum minutely and profusely punctate, the disk beyond the short anterior lobe regularly enlarging, gently in the ♀, considerably in the ♂; the lateral carinæ are rather sharply angled and the deflected lobes expand considerably. Tegmina slender, equal, the extremity very regularly rounded. Hind femora furnished beneath with distant slender spines, the other femora with merely one or two near the tip; hind legs long, the tibiæ being nearly three-fourths the length of the tegmina. Last dorsal segment of the ♂ abdomen with slight posterior, lateral, conical projections, between which the apex is concavely excised; supraanal plate small, conical; upper and lower teeth of anal cerci bent pretty strongly backward as well as inward, straight, conical and similar excepting in size; styles slender, cylindrical, bluntly pointed, a little shorter than the lower tooth of the anal cerci. Ovipositor comparatively short, reaching the tip of the tegmina, much shorter than the hind tibiæ.

Length of body, ♂, 26 mm., ♀, 27 mm.; of fastigium beyond front edge of eyes, ♂, ♀, 2.25 mm.; of pronotal disk, 7.5 mm.; of tegmina, ♂, 34 mm., ♀, 36 mm.; of hind tibiæ, ♀, 24 mm.; of ovipositor, ♀, 20 mm. 1 ♂, 2 ♀. Cuba, received from Prof. Poey, Dr. Packard and Mr. Wright. The ♂ is imperfect.

This species, which, with the last described, belongs in the group with uncinate fastigium, is very distinct from the preceding and from *C. uncinatus* Harr. in the much longer legs and the arched fastigium.

93. Conocephalus cuspidatus. A small and exeedingly slender species; green, the pronotum embrowned. Fastigium of excessive length and slenderness, subconical, tapering considerably just in front of the eyes, then equal, and on the apical half tapering to a blunt tip; its width in the middle is a little less than half that of the head directly behind the eyes; its length beyond the hinder edge of the eyes that of the pronotum; its surface, like that of the rest of the head and of the pronotum, is profusely and distinctly punctate; beneath it is tumid, glistening, distantly and coarsely punctate, its basal tooth pressed against the front of the head, completely closing the frontal incisure, its lateral edges slightly marked in brown. Pronotum very slender, the disk scarcely enlarging posteriorly, the posterior about two and one half times longer than the anterior lobe, the lateral carinæ tolerably distinct, the lateral lobes deflected almost vertically. Tegmina exceedingly slender, the apex regularly rounded. Fore and middle femora destitute of any conspicuous spines (hind legs wanting). Ovipositor short, not nearly reaching the tip of the tegmina.

Length of body, 28 mm.; of fastigium beyond front of eyes, 4 mm.; of pronotal disk, 5 mm.; of tegmina, 36 mm.; of ovipositor, 17 mm. 1♀. Cuba, Prof. Felipe Poey.

The very attenuated form of this species gives it a certain general resemblance to the Acridian genus Leptysma Stål.

94. Conocephalus prora. A small and very slender species; brown, the fastigium immaculate, or, possibly, the extreme tip brown. (The specimen at hand has been in alcohol and is a little browner at the tip). Fastigium of great length and slenderness, the basal half equal, the apical tapering gently to a very blunt, broadly rounded, almost excised tip, the whole extending nearly as far beyond the front edge of the eyes as the length of the posterior lobe of the pronotum; the upper surface is gently convex, scabrous, more distinctly so than the heavily punctured head and pronotum, and its lateral limits are marked by a scarcely noticeable carina; beneath rounded, similarly scabrous, with no depending basal tooth, the median line being in complete continuity with the face and hardly separated from it by the frontal incisure, since this is almost completely closed. Pronotum very slender, the disk scarcely enlarging posteriorly, the posterior nearly three times longer than the anterior lobe, the lateral lobes deflected almost vertically, the lateral carina distinct but well rounded. Tegmina very slender, the apex regularly rounded. Hind femora very slender, armed on apical half beneath with a few oblique spines; fore and middle femora unarmed; hind legs short, the tibiæ being less than half as long as the wings. Ovipositor rather short, about as long as the hind tibiæ, not reaching the tips of the tegmina.

Length of body, 27.5 mm.; of fastigium beyond the front of the eyes, 3.25 mm.; of pronotal disk, 5 mm.; of tegmina, 36 mm.; of hind tibiæ, 15 mm.; of ovipositor, 16 mm. 1 ♀. Palvon, San Geronismo, Nicaragua, McNiel.

This insect belongs in the same group as that last described.

95. Conocephalus acutulus. A small and very slender species, brown, marked with a few obscure fuscous dots along the edges of the tegmina, the fastigium apparently immaculate. Fastigium of great length and slenderness, tapering regularly and gently to a blunt tip, reaching half as far beyond the front edge of the eyes as the length of the posterior lobe of the pronotum; the upper surface is flat, scabrous like the head and more densely scabrous than the pronotum, its lateral margins angulate; beneath rounded, faintly scabrous, shining, with a basal triangular blunt tooth of moderate size, making the lateral view of the lower surface a little concave, and separated from the front by a pretty wide frontal incisure. Pronotum slender, the disc enlarging regularly and gently, the posterior lobe three times as long as the anterior and twice as broad as its extreme breadth, the lateral carinæ distinct but not sharp, the deflected lobes pretty nearly vertical, but not so much so as in the preceding species. Tegmina very slender, the apex rounded, a little produced, the tip below the middle. Fore and middle femora with one or two inconspicuous spines beneath; hind femora very slender with small distant spines on the apical half or more; hind legs short, the tibiæ being about half as long as the tegmina. Last dorsal segment of the ♂ triangularly produced on either side between the cerci, each triangle less than half as long as broad and produced at apex into a minute short finger; supraanal plate small, triangular, bluntly rounded at tip; superior tooth of anal cerci incurved and strongly arched, with a fine long point; inferior tooth conico-cylindrical, bent abruptly inward and forward, straight, blunt tipped, but bearing at lower edge of apex a minute spine; styles very slender, cylindrical, as long as the lower tooth of the cerci.

Length of body, 28.5 mm.; of fastigium beyond the front of the eyes, 2.75 mm.; of pronotal disk, 7 mm.; of tegmina, 35 mm.; of hind tibiæ, 17 mm. 1 ♂ (from alcohol). California, Jan. 20, Dyer.

This species is closely related to the last, from which it is readily distinguished by the greater length of the pronotum, as also by the longer hind legs and differently fashioned fastigium, which at first sight appears to have much the same form. With the last two species it forms a peculiar group of Conocephalus, remarkable for the slender form, great length of fastigium, flattened eyes and vertical declivity of the deflected lobes of the pronotum; in its comparatively shorter fastigium, longer pronotum and less vertical deflection of the lateral lobes, this species make a passage to the group to which *C. ensiger* Harr. belongs.

96. Conocephalus malivolans. A medium sized species, moderately slender, brown; the sides yellowish brown, the top of the head infuscated and the disk of the pronotum with a pair of blackish fuliginous, narrow, lateral stripes which extend a short way upon the base of the closed tegmina, which have a few blackish fuscous dots scattered about; the tips of the hind femora and, to a less degree, the whole of the hind tibiæ are slightly infuscated, the latter also marked beneath the base of the black spines with fuscous dots. Fastigium of moderate size but unusually slender, extending in front of the eyes only as far as the width between the eyes; at its very base it is abruptly narrowed, forming beyond it a subequal prominence slightly swollen on the sides, the tip bluntly pointed; the upper surface is transversely rounded, and like the head sparsely and rather faintly punctate; beneath it is a little tumid, with a coarse basal tooth hardly breaking the continuity of the front of the fastigium and the head, and separated from the latter by a distinct though slight frontal incisure. Pronotum scabro-punctate, subcylindrical, the lateral carinæ quite obsolete excepting on the posterior part of posterior lobe, and the deflected lobes curving insensibly from the disk; posterior margin nearly straight. Tegmina only as long as the body and scarcely longer than the hind tibiæ. Fore and middle femora with one or two short spines on the apical half of the anterior lower carinæ; posterior femora slender, the apical half armed beneath on both carinæ with distant spines; hind legss hort, the tibiæ being a little more than half as long as the body. Last dorsal segment of ♂ abdomen strongly produced, on either side above and just within the cerci, into an arched, sharply pointed, triangular, thickened and apically compressed plate more than half as long as the cerci, the sides of the triangle a little concave; supraanal plate large, triangular, deeply bifid at tip, the two sides sharply pointed; anal cerci stout, incurved apically, both teeth arched and directed inward, the upper bulbous, directly overlying the under, the latter conical, both armed at tip with a finely pointed spine partaking of the curve of the arch and turned a little forward; styles large, equal, bluntly rounded at tip, depressed and canaliculate above, nearly as long as the anal cerci.

Length of body, 28 mm.; of antennæ, 57 mm.; of fastigium in front of eyes, 2 mm.; of tegmina 19.5 mm.; of hind tibiæ 16 mm. 1 ♂. Cedar Keys, Florida, June 4, A. E. Schwarz.

The brevity of the tegmina (hitherto unknown in Conocephalus ?) and the form of the fastigium give this insect a slight resemblance to Orchelimum.

97. Conocephalus aries. A small but comparatively stout species, green, with fuscous flecks on the wings and minute blackish spots beneath the base of the spines on the legs, the lateral and frontal edges of the fastigium yellow, narrowly margined below with black. Fastigium short, stout, blunt, the basal third, from front edge of base of eyes, tapering rapidly; beyond equal, the tip broadly rounded, the length from front edge of eyes considerably less than the breadth at base, half as long again as the width in middle, the upper surface transversely arched, rounding insensibly to the sides, the surface scarcely scabrous; beneath the whole forms a short, conical, depending process, separated from the conically produced front by a pretty wide frontal incisure. Pronotum short, subscabrous, the posterior somewhat more than twice as long as the anterior lobe, the median incisure open U-shaped, the posterior lobe rapidly expanding on its basal two-thirds, the lateral carinæ distinct on the posterior half of the whole pronotum ; posterior edge nearly straight. Tegmina pretty slender, rather regularly rounded at the extremity, the tip scarcely produced and slightly below the middle. Fore and middle femora with two or three pretty stout spines on the apical half of the lower outer carina; hind femora moderately stout, furnished beneath with rather distant, pretty stout spines, excepting next the base; hind legs rather short, the tibiæ two thirds as long as the tegmina. Last dorsal segment of the ♂ abdomen produced as in *C. malivolans*, but much more briefly and neither arched nor apically compressed; supraanal plate moderate, triangular, depressed toward the middle so as to be canaliculate, the sides roundly excised, the apex pointed; upper tooth of anal cerci forming an inward directed, recurved and slightly downward trending, pointed hook; lower tooth long and slender, appressed, conical, in- and recurved, rather bluntly pointed, with a continuous apical spine ; styles slender, cylindrico-conical, as long as the lower tooth of the anal cerci; ovipositor (in the pupa) considerably longer than the hind tibiæ.

Length of body, 27 mm. ; of fastigium beyond the front edge of the eyes, 2 mm. ; of pronotum, 7.5 mm.; of tegmina, 34 mm.; of hind tibiæ, 21.5 mm. 3 ♂, besides 1 ♂, 2 ♀, (pupæ). Mexico, April, Sumichrast.

This seems to be distinct from any of the species which have been described from Mexico by Saussure and Walker.

98. **Conocephalus hebes.** A large but not very stout species, green or brown ; and when the latter, the upper edge of the deflected lobes of the pronotum and of the anal area of the tegmina marked with a slender, blackish brown stripe, which continues to and around the fastigium; the front of the fastigium is also marked with black in the green specimens; and sometimes the tegmina, in the brown variety, are flecked irregularly and infrequently with black dots near the middle line. Fastigium stout, short, subequal beyond the narrowing base, broadly rounded at tip, extending scarcely further beyond the front edge of the base of the eyes than the width between the eyes, not more than one-fourth longer than the median

breadth; upper surface nearly flat, scarcely rounded, a little scabrous, the sides separated from the summit by a distinct though slight carina; beneath, the whole forms a depending pointed cone, whose sides are scarcely less than a right angle with each other, and are separated by a pretty wide frontal incisure, by the slightly tuberculated tip of the front of the face which it overreaches. Pronotum densely punctate, broadening regularly from in front backward,[1] more strongly in the ♂, the lateral carinæ distinct, though blunt, throughout, the hind margin gently convex, the deflected lobes sloping gently and regularly from a vertical position. Tegmina very long, moderately slender, very gently curved, the tip rounded, only a little below the middle, scarcely produced. Fore and middle femora with two or three minute teeth on the lower anterior carina; hind femora slender, delicately spined along nearly the whole under surface; hind legs long, the tibiæ half as long as the wings. Last dorsal segment of the male abdomen deeply and very widely notched, being produced posteriorly at the sides to a large triangular tooth, slightly uncinate at tip; anal cerci stout, short and arcuate, the upper tooth very small, tumid, with a pretty long incurved and slightly recurved spine, lying almost upon the upper tooth, which is stout, compressed, conical and straight, directed inward and forward, armed at tip with a slight thorn; styles slender, cylindrical, tapering on the apical half to a blunt tip half as long as the anal cerci; ovipositor a little longer than the hind tibiæ, not quite reaching the tip of the tegmina.

Length of body, ♂, 33 mm., ♀, 36 mm.; of fastigium beyond the front edge of the eyes, ♂, ♀, 2.25 mm.; of pronotum, ♂ 10 mm., ♀, 9.5 mm.; of tegmina ♂, 48 mm., ♀, 57 mm.; of hind tibiæ ♂, 27 mm., ♀, 27.5 mm.; of ovipositor, 30 mm. 1 ♂, 7 ♀. Cuba, received from Dr. Gundlach with the Nos. $\frac{71}{107}$ and $\frac{59}{113}$; St. Thomas, received from Mr. P. R. Uhler; N. Orleans, from Mr. A. Sallé; San Mateo del Mar, Tehuantepec, about lagoons, collected in February by Sumichrast; and from an unknown locality collected by Xantus.

This species is very closely allied to *C. obtusus* Burm., but differs from it in its longer legs, rather shorter fastigium and somewhat differently constructed male abdomen.

99. Conocephalus retusus. A small and slender species, green, with a very faint pale band around the borders of the fastigium, more distinct and broader on the sides, edged beneath, in front only, and very obscurely with a slight dash of fuscous. Fastigium short, blunt, equal beyond the narrowing base, well rounded at tip, extending beyond the front edge of eyes only two-thirds the distance of the space between the eyes; upper surface tumid, very faintly scabrous like the rest of the head; lower surface forming a depending, blunt, conical projection, separated by a pretty wide frontal incisure from the tuberculate tip of the face. Pronotum profusely punctate, the median incision V-shaped, the posterior three times as large as the anterior lobe, the latter expanding regularly but very slightly backward, the lateral carinæ distinct, the deflected lobes much as in the preceding species. Tegmina long and very slender, the extremity rounded with the slightly produced tip before the middle. Fore and middle femora unarmed; hind femora exceedingly slender with eight to ten distant delicate spines on about the middle third of the under surface; hind legs very long, the tibiae nearly as long as the body, ovipositor very long, nearly as long as the tegmina.

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[1] In a single ♀ from St. Thomas, which otherwise does not differ from the others, the disk of the pronotum is equal throughout.

Length of body, 31 mm.; of fastigium beyond the front edge of eyes, 1.8 mm.; of pronotum, 7 mm.; of tegmina, 37 mm.; of hind tibiæ, 28.5 mm.; of ovipositor, 32.5 mm. 1 ♀. Georgia, H. K. Morrison.

This is the slenderest species of this group of Conocephalus known to me. It resembles the much shorter legged *C. dissimilis* Serv., a species which I formerly confounded with *C. obtusus* Burm.

100. Conocephalus clausus. A large and stout species, brown, the disk of the pronotum darker, with narrow lateral stripes of darker brown, the tip of the fastigium, above rather than in front, marked with fuscous. Fastigium large and tumid, constricted at the base just in front of the eyes, beyond subglobose, the whole of equal length and width counting from beyond the front edge of the eyes, and a little narrower than the space between the eyes; top of the head scabrous, including the middle of the fastigium as far as the tip of the first antennal joint; the rest of the front and sides as well as the under surface smooth and shining; viewed from in front, the lower part forms a depending, stout, blunt-tipped cone, which is attingent with the short tubercular tip of the face, completely closing the frontal incisure; face sparsely punctate. Pronotum rather sparsely and irregularly punctate, the posterior lobe about two and a half times longer than the anterior, the hind border nearly straight, the lateral carinæ apparent only on the posterior half of the posterior lobe, the deflected lobes unusually vertical. Tegmina rather long, somewhat broader than usual, well rounded at tip, the apical curve in advance of the middle. A few tolerably stout spines on the under surface of fore and middle femora; hind femora rather stout, armed beneath with rather frequent spines; hind legs rather short, the tibiæ less than half as long as the wings, ovipositor broader than usual and only as long as the hind tibiae.

Length of body, 40 mm.; of fastigium beyond the front edge of eyes, 2.8 mm.; of pronotum, 9.5 mm.; of tegmina, 51.5 mm.; of hind tibiae, 22.5 mm.; of ovipositor, 22.5 mm. 1 ♀ (from alcohol). Jalasco, Mexico, Dr. Berendt (Smithsonian Institution).

In closing this series of descriptions of Orthoptera, which have appeared at intervals during the past ten years, it will be well to indicate a few changes of nomenclature which are necessary.

No. 3. Saussure corrects the spelling of the generic name Hapithus to Apithes, deriving the name (correctly, as its deviser Mr. Uhler informs me) from ἀπειϑής.

No. 11. The generic name Stålia, named in honor of the late Dr. C. Stål of Stockholm, was preoccupied by its use in Hemiptera by Reuter a short time previously. I would therefore propose for *Stålia foliata*, the generic term Eustålia.

Nos. 23–30 and No. 61, for reasons given in the Proceedings of the Boston Society of Natural History, Vol. XIX, pp. 281–86, should be referred for the present to Melanoplus. Further change may be required when I have completed the revision of the Calliptenoid series of N. American Acridii, upon which I have been for some time engaged. The name of *Caloptenus fasciatus* being preoccupied, I have replaced it (Proc. Bost. Soc. Nat. Hist., XIX, 289) by *M. Packardii.*

No. 65. *Hippiscus lineatus.* This species I had formerly described (in MSS) under the new generic name Cratypedes, but before publishing, considered it best to include it in Hippiscus. I do not recollect that I have ever mentioned this name to any one and have never seen more than the single specimen of the species upon which I had proposed to found it, and which has never left my collection. It was therefore a complete mystery to me to find a closely allied species described by Mr. Thomas (Proc. Davenp. Acad. Nat. Sc., I, 257–58) as *Cratypedes Putnami*, with the remark "I have placed this species in this genus with some hesitancy, yet it certainly agrees very closely with it." I disclaim any proprietorship in the generic name, and do not know to what Mr. Thomas refers. This remark is offered simply to aid any future student who may search for the origin of the name.

EXPERIMENTS ON SPONTANEOUS GENERATION. BY A. T. PARKER, OF LEXINGTON, KY.

For several years past I have made many experiments with a view to determine the possibility of Archebiosis or spontaneous generation. My earlier experiments produced such varying results that, until within the past year, my mind remained in uncertainty. In these earlier experiments I overlooked what I now consider important elements most essential to the solution of the problem. A brief sketch of these tentative essays will be necessary in order to a proper appreciation of the conclusive experiments of the last year.

In all my experiments, glass flasks were used containing infusions of various substances carefully sealed. In most instances, the usual method of experimenters was adopted, the substances employed being cut into small pieces and macerated in warm water for several hours, when the infusions, after filtering, were poured into glass flasks, in which they were boiled by the heat of a spirit lamp, and, while boiling, the flasks were sealed by means of a blow-pipe. The infusions used were such as are admitted to be most conducive to the origin and development of the germs of primordial life. It is unnecessary to detail the many experiments of the first three years. In these earlier and unsatisfactory experiments, I found in almost all the infusions living or dead organisms. Some flasks contained only inorganic matter. In other flasks were fully developed living active bacteria and vibriones. In other flasks, dead bacteria were found in great numbers, while, in others still, were found both living and dead organisms. These very dissimilar results were often obtained from the same series of flasks, containing the same infusions, prepared at the same time, and surrounded seemingly by the same conditions. Such varying phenomena were very perplexing. Whence the living bacteria ? Had they survived the heating of the infusion ? or, were they developed in the flask after it was sealed ? Whence the dead organisms ? Were they developed in the infusion after it was sealed up in the flask, and did they afterwards die ? Or were they already developed in the infusion when placed in the flask, and destroyed by the heat to which the infusion was then subjected ? Again, whence the living and dead bacteria contained in the same flask ?

I instituted a new series of experiments to determine these questions. I first subjected infusions prepared as before to microscopic examination before boiling and again after boiling. I found in every instance that where living organisms existed in the infusions before boiling they were found dead in the infusion after it had been subjected to boiling heat ; thus establishing the fact that while these organisms were killed by the heat of boiling water they resisted disintegration, and their remains were found in the infusions after boiling. I next prepared other infusions in the same manner as before, macerating the substances in warm water, and then filtering, boiling, and sealing them in flasks. But I now, after maceration, subjected a part of each infusion to microscopic examination before boiling; and after boiling, another portion was examined with the microscope, while the remainder was placed in flasks boiled with the flame of a lamp and sealed during ebullition. In all such experiments, when living bacteria were found in the infusion before boiling, I found dead bacteria after boiling, and also in the flasks when after an interval ranging from a few days to several weeks they were opened ; showing that the bacteria had developed during the maceration, and were destroyed during the heating process. In a great number of these flasks living organisms were found upon opening them, and these were found in flasks containing infusions in which no life was found in the first examination. In all such instances the questions arose, did the organisms originate in the infusions in the flask ? or did air enter during or after the process of sealing the flask which contained the germs that afterward developed into life? In experiments carefully made with a view to determine this question, I found it extremely difficult to seal the flasks so securely as to exclude air altogether, owing to the pressure of steam from the boiling liquid upon the neck of the glass softened by heat in the process of sealing. I found that often, when a flask seems securely sealed, air will enter through some minute aperture formed by the contraction of the glass during the process of cooling. By inverting the flask the entrance of the air may be perceived by the bubbles which rise through the liquid. The difficulty of sealing the flasks, and the impossibility of knowing whether a perfect sealing has been effected invalidates all experiments conducted with flasks filled and sealed by the usual method.

In view of the difficulties attending these experiments, and the inexplicable results, I undertook, about a year ago, to work upon a new plan. In this series of experiments the utmost precautions were taken; the flasks, pipettes, etc., were all new and unused. Before using them they were thoroughly washed in acids, alcohol, and boiling water. The objects to be attained in these experiments were first, to secure a perfect sealing of the flask; second, to know the exact nature of the infusions inclosed. To secure the first object I determined to seal the flasks first and then expose them to heat after being sealed. To this end I adopted the following process. Such substances were used as are regarded most favorable for the development of life. These were properly prepared by maceration in warm water for from one to two and a half hours. The infusions were then filtered three times successively through different pieces of filtering paper; portions of the filtered infusions were then placed in flasks and carefully sealed with spirit lamp and blow pipe. A strong copper vessel[1] was prepared capable of enduring a pressure of one hundred and fifty lbs. to the square inch, in which to boil the infusions. In this vessel were two unions; the coupling of one of them being closed at its bottom was filled with fish oil in which was inserted a thermometer; through the other union the sealed flasks containing the prepared infusions were introduced. The copper vessel was then nearly filled with water. Proper precautions being taken for the exclusion of air a spirit lamp was applied, and the degree of temperature noted as indicated by the thermometer. In order to keep my judgment unbiassed during these experiments while opening and examining the flasks, and also to be able to determine whether any changes had taken place in the fluids after their enclosure and heating, I adopted a peculiar system of recording the experiments. A few drops of each infusion as prepared for the flask were placed upon a slide having a concave cell, and a one-tenth immersion lens made by Wales was focussed to the bottom of the cell, and the contents carefully examined every few minutes for an hour. A careful record of its condition was entered in a book for the purpose. The flasks were numbered and each number entered in connection with the recorded character of each flask. When afterwards the flasks were opened and scrutinized, another record was made in another book. It is important to state that the first record was not referred to, nor was a comparison made between the two records until all the investigations were completed. Consequently the contents of the flasks and the nature of the infusions were unknown at the time of their examination. By this system of record and comparison the changes in the fluids, if any occurred, could be easily discovered. For, if the first record showed a special organism, say, rod-like bacteria, existing in any infusion to the exclusion of all other forms of life, and if after a lapse of time sufficient for all the possible changes to take place of

[1] See plate 1.

which the infusion was susceptible, that organism was found dead, and no other organisms were found, and no development of any spores or germs which it may have contained at the time of its inclosure, it might then, under these circumstances, be concluded that through the agency of heat all the organisms in the fluid had been destroyed, and the fluid itself rendered incapable of developing or maintaining life. It is well-known that all animal and vegetable substances that have been long exposed to the atmosphere become the habitat of various germs that float in the air, and that these germs under favorable conditions in an incredibly short time begin to reproduce themselves by millions. It is not so generally known that many of these germs are so small as to pass with little seeming hindrance through the finest filtering paper. For example, a handful of green white clover was cut in the month of July — a fragment of cheese was added and the whole covered with warm water. At the end of two and a half hours, a drop showed a large number of vibriones and jointed bacteria of small size, and in six hours after its preparation, a drop was swarming with millions of these organisms. This infusion was passed through fine filtering paper four times, the filtering medium seeming to offer little or no resistance to their passage. A drop from the filter showed myriads of them, very active and their numbers scarcely diminished.

In detailing the following experiments it may be necessary to state that cognizance was taken only of the most prominent forms present in the infusion, it being understood that in almost all infusions some particular organism largely predominates.

The first experiment consisted of nine flasks, closed January 18th, of the following infusions, — one of simple milk, four of hay, three of turnip with a small addition of cheese, and one of turnip and milk. They were all heated to 100° Cent. (212° F.) for thirty minutes. The flask containing milk was opened on the ninth day after sealing. Neither bacteria, vibriones, nor torula could be found, but large numbers of milk globules filled every field of view. The hay infusions were opened and examined on the twelfth, sixteenth, and nineteenth days after sealing. A very few bacteria — all dead — were found in the deposits. The flasks containing turnip and cheese, and the one turnip and milk, were opened on the seventeenth day, and found to contain milk globules only. The second lot of flasks consisted: four of parsnip with a small addition of sodic phosphate, three of urine with liquor potass. added, two of the juice of beef, and two of urine alone. These were kept at a temperature of 100° Cent. (212° F.) for thirty minutes. The parsnip infusions were opened on the sixteenth, twentieth, and twenty-second days. Nothing was found in the deposits except granular matter. The flasks containing urine with liquor potass. added, were examined on the tenth, fifteenth, and nineteenth days after sealing, with the same result. The flasks containing the juice of beef were opened in eight and ten days after closing, and the infusions were found to exhibit fat globules only. The flasks containing simple urine were examined on the tenth and seventeenth days after sealing. They showed not a vestige of any organism.

On April 9th, a third lot of twelve flasks were prepared and sealed, viz.: four of hay, three of green clover, three of turnip, and two of parsnip. To these nothing was added. They were kept at a temperature of 120° Cent. (248° F.) for one hour. On the fourth day, one of the flasks containing the infusion of turnip was opened. The other two remained closed until one hundred days had elapsed. The deposits were found to consist of granular matter. The flasks containing hay infusions, were opened on the twenty-first, forty-second, and forty-seventh days. In the deposits were found a small number of jointed bacteria — all dead.

The flasks containing parsnip were opened on the forty-second day. A few needle-like crystals only were observed, imbedded in a mass of granular matter. The flasks containing clover infusion were examined on the forty-second, forty-seventh, and one hundred and sixth days. The deposits were made up of rod-like bacteria, all dead, and inorganic matter.

The next series, consisting of seventeen flasks, was closed June 29th. Ten contained hay infusion with cheese added, and seven the same infusion without any addition. These were carried to a temperature of 145° Cent. (293° F.) and were kept at that point for one and one-fourth hours. None of the flasks containing the hay and cheese infusions were opened earlier than the forty-second day, and most of them were not examined until one hundred days had elapsed. In the deposits of all there were found thousands of dead vibriones of the necklace type, to the almost entire exclusion of all other organisms.

On July 23d, thirteen flasks were prepared, five of hay and cheese, four of hay to which was added about an equal quantity of stable manure, and four of simple hay. These were heated to a temperature of 145° Cent. (293° F.)for one hour, and were kept above 100°

Cent. (212° F.) for two hours. One of the flasks containing hay and cheese was opened on the one hundred and eighth day after sealing; another was opened on the one hundred and twenty-fourth day; the three other flasks containing hay and cheese were broken during the process of heating. In those examined, jointed bacteria — all dead — were present in limited numbers. The flasks containing hay and manure were opened one hundred and thirty days after sealing. Only a few cells and oxalate of lime were found amid an ample deposit of inorganic matter. In all these experiments the infusions were examined under the microscope at the time of sealing as already mentioned, and a record made of their condition, and a similar record when the flasks were opened.

Following my order of work, I will detail my further experiments before giving a comparison of the records.

In the following experiments the usual course of steeping infusions in *warm* water was changed, boiling water being used in covering the substances to be infused; and, instead of suffering the infusions to cool, they were boiled for ten minutes in an open vessel and immediately filtered and sealed — the entire process occupying not over half an hour. This process was adopted because it insures a strong infusion, and also shuts out the possibility of organism being developed in them and multiplying before the final heating. The first of these infusions were prepared July 30th, and consisted, four of hay, and two of hay and manure.[1]

The simple hay infusions were opened on the sixth, fourteenth, and one hundred and twenty-second days after sealing. A few dead bacteria were found in the deposits, associated with myriads of inorganic particles. The flasks containing hay and manure were opened on the seventh and fifteenth days after sealing. In the deposits of both these flasks, besides the usual number of bacteria that abound in all the deposits from the hay infusions, large numbers of crystalline cubes of small size were observed. These had a tendency to aggregate and form groups which bore a great resemblance to Sarcina.

Nine flasks were closed Nov. 5th, viz., one of turnip with cheese added, one of simple urine, and seven of hay and cheese. These were carried to a temperature of 140° Cent. (284°F.) at which they remained one hour. The urine was opened and examined on the forty-second day. No organisms were present in the deposit.

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[1] Stable manure was used because it contains both animal and vegetable matter in a state of decomposition.

The turnip and cheese infusion was opened on the fiftieth day, in which nothing organic was seen. The hay and cheese infusions were examined on the twenty-first, sixtieth and sixty-second days, with the same results.

The statement having been made that life is more surely developed in fluids enclosed in vacuo, I decided to prepare a number of flasks to determine whether different results would be obtained by this means. The plan adopted to secure a vacuum being somewhat novel, it may be well to describe the process. Distilling flasks of about four ounces capacity were used. A rubber tube about six inches long was forced over the arm; the flasks were then half filled with the fluids; the corks were pressed into their necks, and a piece of sheet rubber was placed over each cork and securely wrapped around the neck of the flask. They were then placed upon a retort stand and brisk boiling kept up for fifteen minutes, and, while the steam with jets of the infusions were pouring out of the rubber tubing, a pair of clamps with a strong spring was applied to the tubing. The lamp being immediately removed and condensation taking place, the tubing became flattened as a ribbon, and so remained until the flasks were opened. The vacuum obtained by this process was so complete that in some instances, flasks that were unusually thin, were shattered in pieces by the outside pressure of the air. Although a number of flasks were prepared in this manner containing various infusions, and afterwards surrounded with the most favorable conditions, the results were identical in every particular with those obtained with flasks containing air.

Having completed my experiments, I turned to the first record of the examination of the infusions made at the time they were sealed. It is a remarkable fact that in every instance the record of the condition of the infusion in each flask at the time it was sealed, agreed perfectly with the record of the same made when the flasks were opened. In no instance did the examination made when the flasks were opened, show organisms when none were present at the first examination. When the presence of organisms was recorded in the first examination, the second record showed the same organisms, and in the same condition, without having undergone any change whatever; in no instance was a different organism present. The first examinations of urine, milk and turnip infusions, showed that they were free from bacteria, vibriones, and their allies, and, regardless of the length of time the flasks remained closed, those organisms never appeared in them ; when, however, hay was used in making the infusions, they were almost invariably found, both at the time of sealing and afterwards upon opening the flasks. These facts lead to the conclusion that no life was in any case developed after the flasks were sealed, but that in all instances the organisms present had their origin in atmospheric germs. Urine and milk sealed without a long exposure to the air showed no organisms, either when the flasks were sealed, or afterwards when they were opened. Infusions of turnips (the turnips being peeled and washed before infusion, so as to remove from them any germs previously derived from the air) were also free from organisms. But, when hay or clover was used, organisms were always present. This may be attributed to the fact that their stems could not be freed from germs previously lodged upon them from the air. When the infusion was made by steeping for several hours in warm water these organisms multiplied greatly, and passing freely through the filtering paper, were present in multitudes in the infusion when sealed, and being killed in the boiling process were found dead when the flasks were opened. On the other hand, when infusions were made by boiling, the few germs present upon the hay had no opportunity to multiply, and only a few were present in the infusions before sealing, and were found dead (killed by heat) when the flasks were opened. I am sure that the mere finding of dead bacteria or their allies in deposits, is no evidence that they had origin in the infusions, or that the infusions underwent any changes. In proof that no change occurs either in the infusions, or in any of the germs and organisms that exist in the infusions before heating, take for example three of the several series of flasks examined. It has been stated that on June 29th, seventeen flasks were prepared, viz., ten of hay with an addition of cheese, and seven of hay only. None of the former were examined earlier than the forty-second day, and one hundred and eight days were suffered to elapse before the last flask was opened. By a comparison of the records, we find that the first record mentions organisms as abounding, and described to be of the necklace type and a drawing of them was made, showing the number of beads or joints of the largest. In the subsequent examination of these ten flasks, these necklace bodies were always found, and in about the same numbers. The other infusions of hay without anything added, were opened from the fourteenth to the one hundred and fiftieth day. The organisms in these were in every instance described as jointed bacteria, to the almost utter exclusion of all other forms. In other examples, hay and manure were used in making the infusion. The first record states that a few rod-like bacteria were seen, and also crystalline cubes, which by aggregation resembled Sarcina. These flasks were opened in from ten to forty days. Every statement made at the last examination coincides exactly with the first record. So, in every case running through the whole series of experiments, there is the most perfect agreement between the two records. So much alike are they, that the language employed in both descriptions is almost identical.

From these experiments, we are forced to the conclusion that there is not a shadow of evidence that any of the organisms found in the infusions, originated in them after heating. All the facts on the contrary go to show that the infusions were not capable of originating life. It is very common for those who hold the theory of Archebiosis to state, as the result of experiments, that only a part of the whole number of flasks containing *the same fluids, prepared at the same time, and surrounded by the same conditions* are prolific, the rest being sterile. This seems to be impossible, for it would compel us to admit that one part of a particular infusion has the life-producing property, while the other has not. Now this state of things might be explained if some of the fluids were exposed to the air by being imperfectly sealed. But when all are hermetically sealed, they are removed from all external influences except light and heat; and as each fluid receives the same proportion of these, this important variation is unaccountable, and difficult of belief. The question arises why investigators in this field of inquiry, conducting experiments upon the same general plan, reach such different results. The experiments described above throw some light upon this subject.

Judging from these experiments, different results seem to arise from a variety of causes, some of which I will mention. In general it may be stated that the different results do not arise from what is seen, so much as from a wrong interpretation of observed phenomena; and especially from not paying due regard to the probable sources from which many vitalized bodies may be derived. Many errors have originated from ascribing to vital action, the motion that all microscopic bodies assume when their own density nearly approaches that of the fluid in which they are found, and which may be due to evaporation, or to molecular or such other changes as the fluids may be undergoing. Another source of error is the belief that filtering liquids frees them from all organisms previously contained —

a very serious error. My experiments demonstrate the fact that organisms pass with facility through the finest filtering paper, and consequently are found in the deposits. Another very common source of error is the imperfect sealing of the flasks. Many flasks sealed with the spirit lamp and blow-pipe in the usual manner will, if inverted, show the imperfect sealing by the bubbles of air passing up through the liquid from an imperceptible aperture left in the sealing process. Still another common source of error is the belief that in a given infusion certain organisms will always appear in the same length of time. So far from this being the case, it is well known that an infusion will at one time, swarm with bacteria and other low forms of life in a few hours; while, at another time, an infusion prepared in the same manner and surrounded, so far as can be seen, by the same conditions, may remain for a considerable time without any indication of life. The above are the mistakes most likely to occur with experimenters in this field. The greatest care and attention are necessary to avoid them, the subject being beset with difficulties on every hand. The exaggerated statements respecting organisms apparent in flasks supposed to be hermetically sealed, and heated to the point of boiling water, at which all living things must perish may probably be traced to some one or other of the mistakes above enumerated.

Note. One feature observed in connection with the experiments described was the entire absence of pellicles in the flasks at the time they were opened. These are always mentioned by experimenters as being associated with all prolific fluids. They were searched for, but in no instance was such a thing found. All the infusions remained as pellucid as on the day of their inclosure. The only change seen was that the fluid was, in some instances, lighter colored at the time of examination than when sealed. This change of color is to be attributed to the deposition of particles of matter held in suspension in the fluid. These deposits were, in many flasks, perceptible to the naked eye, and in some of them were quite large. All the fluids immediately after being filtered appeared to the naked eye free from floating particles of all kinds. But, as before stated, a few drops of each infusion were placed under the microscope in a concave cell, and an immersion lens was focussed to the bottom of the cell. During these examinations, but little of either organic or inorganic matter was at first to be seen; but if the instrument and slide were permitted to remain at rest and the contents of the cell examined from time to time, a gradual deposition of matter could be seen going on, until, at the end of an hour, the field of view would be found filled with organisms, and such other matter as was held in suspension by the fluid.

General Meeting. November 20, 1878.

Vice President, Mr. S. H. Scudder, in the chair. Twenty-eight persons present.

The following candidates were elected Associate Members: Messrs. W. L. Allen, Geo. W. Hammond, Henry Edwards, Chas. S. Hull, H. G. Kittredge, A. J. Lewis, J. A. Osborn, and H. F. Walling.

The following subjects were discussed: Darwinism and the Human Eye, by Dr. David Hunt, and Growth as a Function of Cells, by Dr. C. S. Minot.

A paper on Early Types of Insects, by Mr. S. H. Scudder, was presented by title. (See the Society's Memoirs III, i, no. 2.)

The Custodian reported a gift of a specimen of *Chimæra monstrosa* from Mr. Wm. Prior, Jr., to whom the thanks of Society were voted.

The following donations to the collection of New England Birds were announced by Dr. T. M. Brewer.

From Frank L. Tileston, Esq.: A fine specimen of the Winter Yellow-leg, *Gambetta melanoleuca*, a female, shot in Chatham, Cape Cod, Nov. 2, 1878.

The Hudsonian Godwit in winter plumage, ♀, same date.

A very remarkable specimen, also ♀, of *Macrorhamphus scolopaceus*, Lawrence, shot at the same time and place.

Mr. George H. Mackay, Esq.: An immature specimen of the Purple Gallinule, *Gallinula martinica*, a semi-tropical species, of rare occurrence in New England. This specimen is said to have been shot in October 1872, near the north head of Hummock Pond, in Nantucket.

Hyperborean Phalerope, *Phalaropus hyperboreus*, shot on the land, in Nantucket, Sept. 20, 1878.

Stilt Sand-piper, shot in Nantucket, July 25, 1878. This is the earliest record in the season, of its occurrence here, and the only positive one of its presence in that part of the State. It was a solitary specimen of its kind and had for its only companion a Summer Yellow-leg.

Mocking-bird, *Mimus polyglottus*, a young ♂ shot in Nantucket, Oct. 8, 1878. It was evidently a wild and not an escaped bird, and is one of the very few recorded instances of the capture of this species in Massachusetts.

Hydrochelidon nigra, Short-tailed Tern. Shot at Hummock Pond, Nantucket, Aug. 8, 1877. It was alone and its flight was not unlike that of the common Tern.

The thanks of the Society were voted for these gifts also.

Section of Entomology. November 27, 1878.

Mr. Edward Burgess in the chair. Eleven persons present.

The following paper was read :

ON LARVÆ OF INSECTS DISCHARGED THROUGH THE URETHRA.

BY DR. H. A. HAGEN.

The larva of an insect which had been discharged through the uretha by a country boy, was sent by Dr. Cutler of Waltham, Mass., to Mr. S. Henshaw, and kindly communicated to me for investigation. The larva is somewhat squeezed and flattened, but otherwise in good condition and belongs to the Dipterous genus Homalomyia. In comparing the larva with the larvæ of Diptera in the biological collection of the Museum in Cambridge (which contains now 380 species of Diptera, more or less fully illustrated) I found two lots of the same kind. One is labeled from putrifying fish, the other, as found in a bottle containing rotten alcoholic fishes. In looking through the American literature I found one paper of the late B. D. Walsh, "larvæ in the human bowels" (Amer. Entomol., II, 137) seeming to treat of similar larvæ. The description and the figure make it nearly doubtless that the larva from Waltham is identical with the *Homalomyia Wilsoni* Walsh. There is only one difference : the larva of *H. Wilsoni* has on the third segment on each side only one filament, while mine has on each side a pair of filaments just as in the following segments. But as all larvæ of Homalomyia, as far as I know, and at least all I have seen, and all figured and described in Europe, possess a pair of filaments on each side of the third segment, I am inclined to believe that the second filament was overlooked by Mr. Walsh. This is the more probable as it is considerably smaller than the other one; and as the lens used by Mr. Walsh was an exceedingly poor one.

Among the European species the larva of *H. scalaris*, well-known and often figured, is very similar, except that the filaments in the American species seem to be more feather-branched. But as I have only a few specimens of the European species before me and the existence of *H. scalaris* in America is proved by specimens in Prof. Loew's collection, the identity of the two species is very probable. Nevertheless the larvæ of all related species are very much alike, and only by the study of a material with raised imagos can a sufficient surety be reached. As by far the largest part of the Anthomyidæ of the collection is still in the hands of Baron von Osten Sacken in Europe, I am not able to give a satisfactory record of the species of Homalomyia belonging to our fauna.

"The cases which I have to relate (begins the well-known Dr. Bateman in his account of the larvæ of two species of insects discharged from the human body) do not possess any practical importance, and the only degree of interest that may be attached to them, must be derived from the uncertainty of medical records on the subject in question. This uncertainty induces me to bring them forward. For whether we consider, on the one hand, the difficulty of accounting for the origin of many of those animals, which make their nidus in the human body, or the variety of indistinct and fabulous histories of such animals which have been detailed on the other, every instance of the existence of those which are not usually found there, but the species of which can be ascertained, and therefore the probable origin pointed out, seems to be worthy of being recorded."

These words are to-day just as true as seventy years ago, for really not much has been done to elucidate the origin of similar cases, except that the occurrence is more or less fully stated in medical periodicals.

Rev. F. Hope published forty years ago a list of one hundred and eight cases, which he found recorded by different authors. Of them thirty-five belong to Coleoptera, two to Dermaptera, six to Lepidoptera, one to Neuroptera, sixty-four to Diptera. Among the Coleoptera the meal-worm, *Tenebrio molitor*, is recorded in nine cases; of the Diptera thirty-seven cases belong to the Muscidæ and twenty to Œstridæ. The composition of the list must have been very difficult; nevertheless it is far from representing all published cases, and sometimes not thoroughly reliable. Concerning the locality affected thirty-six cases belong to the stomach and the intestines, and seven to the urinary organs.

The sex of the patients is given in seventy-one cases, thirty-three men, and thirty-eight women. It is of interest to state that the cases in which Coleoptera are observed show twenty-one women against only four men; the cases in which Diptera are observed, twenty-nine men against seventeen women. But it should be remarked that the Dipterous cases included fifteen belonging to Oestrus, of which fourteen belong to men, who are obviously more exposed to attacks by those flies. Deducting those cases, we find both sexes equally often infested by Diptera. I have tried to bring together all known cases in which larvæ or perfect insects are recorded to have been discharged through the urethra, and give a list of twenty, only three of them published later than Hope's list, in which therefore ten were not included. The sex is recorded for fifteen cases, nine men and six women. The discharged animals show nine Diptera, six Coleoptera, two Oniscus, and a larva without nearer indication. Of the Diptera four belong to Homalomyia, one to Tipula, one to Eristalis; of the Coleoptera three to *Tenebrio molitor*, one to *Ptinus fur*, the only imago of an insect recorded, and two to a larva similar to *Curculio nucum* (!).

The value and reliability of the mentioned cases are far from being equal. In the appended literature, I have stated the particular reasons, which lead me to accept only sixteen of them, and consider only four of these as of much value. Unless it is supposed that mistakes in such observations have not been very generally committed, we are obliged to believe that the discharged larvæ have really been in the bladder, though this organ is the least probable abode for the larvæ of winged insects. Farther, as of course the only open way to the bladder is the urethra, the observed animals must have entered through it. There are indeed true intestinal worms belonging to the genus Strongylus, which, originating in the kidneys, thence enter the bladder, but it is equally obvious that these roads are impassable for larvæ living in the bowels. To those unacquainted with the study of medicine it will seem incredible that things should be put purposely into the human body; but there are cases reported in medical literature, which surpass all belief. The article "corpora aliena in corpore humano" in Rust's Surgical Archives, written by the celebrated Dr. Dieffenbach, gives a large number of the most incredible and nevertheless carefully observed cases.

Concerning the urinary organs, we find in a table drawn up by Professor Civiale of Paris (Gazette des Hôpitaux, 1838), a collection of one hundred and sixty-six cases of foreign bodies in the bladder, in which the following articles were removed from it; twenty-five needles and pins, one bodkin, two ear pickers, six fragments of bones, five teeth, eighteen sounds or bougies flexible and rigid, twelve pieces of wood, six needle cases, one cork, thirteen plant stems, ears of wheat and straws, nine pieces of lint, six pipe-stems, three glass tubes, various kinds of fruits, feathers and hair. Since that time up to 1861, he has extracted nineteen sounds or bougies, a leather strap, two pen-holders, an artist's brush handle, two pieces of bone, a piece of tendon, a lamp wick, a barometer tube, and a medal.

If it is therefore proved that persons in some morbid disposition are themselves apt to put foreign bodies in the bladder, we are allowed to conclude that at least some of the insect cases belong to this category; though no insect or insect larva is mentioned among the bodies removed from the bladder. That an intentional deception has sometimes occurred, is a well-known fact, but other cases are beyond this suspicion, and therefore it is fair to suppose that unpremeditated mistakes have been made in observation. Cases in which such mistakes were developed are recorded, — one by Linnaeus himself. His student Rolander, suffering from dysentery, was believed to have discharged a large number of living Acari, but Linnaeus discovered that the wooden drinking cups in the room were swarming with these insects as well as the one used. Siebold speaks of a similar case in which living specimens of *Ptinus fur* were believed to have been discharged, while later it was discovered that the leather cushion of the stool was infested with the living beetles. The view that the discharged larvæ may have already been in the not thoroughly cleaned vessels, or that they afterwards fell in by chance, perhaps from the cover, is adopted as probable by LeClerc, Rudolphi, Bremser and others. This is doubtless the fact in the cases recorded of Oniscus and the Eristalis larva, and Dr. Bateman recalls judiciously, that the recorded larvae of Muscidae may have been generated in or near the water closet, as they often live in such places. If we adopt this explanation for another set of cases, there still remain some in which, during or after a severe disease of the bladder and the urinary passages, the discharge of some animals gave instantaneous relief, and cure followed. I should have believed these cases more important, if exactly similar ones of instantaneous relief after a discharge of larvae from the bowels had not been observed, the larvae (Homalomyia) being just the same as those often recorded as discharged from the bladder. Dr. Howship in his tract (Observations on the diseases of the urinary organs, London, 1816), has published very striking cases of this class.

Last not least, it is important to notice that all the observed cases belong to men, none to animals, and that in the numerous dissections which have been made the presence of larvae in these organs has never been stated, and that as far as I know, no museum possesses such larvae, professed to have been found in the bladder.

There are certain limits, which can not be transgressed without becoming absurdly credulous, in believing facts, which are said to have been observed. The bold manner in which Linnaeus has purified natural history by throwing out such facts, is certainly one of his greatest merits and has greatly advanced natural history. That he has gone sometimes too far, and that some of the rejected facts have later proved true, is comparatively without consequence. I confess, that I do not believe that larvae of insects can live in the bladder, and that consequently they are not discharged through the urethra — till the contrary is proved by indubitable evidence.

The excellent and well-known works of C. A. Rudolphi and J. G. Bremser, contain the literature up to 1819. Nevertheless as the aim of both authors is to give a history of the true intestinal worms, all others which belong to the so called Pseudohelminthes are treated only as a side matter. There exist some works, in which the older literature is said to be largely collected.

J. Schenck von Grafenberg, Observat. medicar. rarior. Libr. VII., Francofurti, 1600, (and later Edit.),— Marcellus Donatus, De medica historia mirabili. Libr. VI. Venetiis, 1597. 4to.—P. Borelli, Histor. te observat. medicophysicarum Cent. IV. Francofurti, 1670, 8° and Cent. I, 1676. — Hercules Saxonia. (title of the work unknown to me) — and W. G. Ploucquet, Initia Bibliothecae medico-practicæ et Chirurgicae realis. Tuebingæ, 1793–97. 4°. I am not sorry that I am unable to compare these works; perhaps there is no copy of them here, as Rudolphi designates them simply as a kind of stuff, of which very little is worthy to be studied, and Bateman, Edinb. med.

Journ. VII, 47, speaks of the very questionable authority of those authors whose credulity is at least equal to their learning and industry.

LIST OF CASES IN WHICH INSECTS ARE SAID TO HAVE BEEN DISCHARGED THROUGH THE URETHRA.

No. 1. Ambr. Paré. Œuvres. 1582. fol. reimpr. Paris, 1841, III, 35. The celebrated father of surgery says L. Duretus is affirmed to have discharged after a long sickness a living animal through the urethra similar to an Oniscus, of red color. LeClerc says similar to a Hog or Wood Louse. A second case reported by Paré is entirely fabulous. I have not seen the figure of Paré, which is omitted in the reprint as being very bad.[1]

No. 2. Nic. Tulpii, Observationum medicarum Libr. III. Amstelodamii, 1641. 8vo. Lib. II, cap. L, p. 178. Undeviginti vermiculi emicti. Tab. VII. f. 2. A prominent physician in Amsterdam, convalescent after an intermittent fever, discharged in one week through the urethra without pain twenty-one larvæ. The figure is not good, but perfectly recognizable as a larva of Homalomyia, probably *H. scalaris*. In the description the tail is taken to be the head. Tulpius says that this larva is very similar to those discharged by Lud. Duretus.

No. 3. Lib. II, cap. LI, p. 179. Cottidianus vermium mictus. Tab. VII, f. 3. A lady fifty years old discharged at the end of a sickness on several days five or six small worms, two of them large, of the size of the joint of a finger. The figure shows probably the meal worm, the larva of *Tenebrio molitor*. The medical prescription to prevent a farther propagation of the worms is carefully noted down, and consists of three medicines containing together a whole pound of twenty different drugs. No wonder that the worms could not stand so uncivil a reception, almost equal to an attack with Krupp guns!

No. 4. G. C. Gahrliep von der Muehlen, Ephemerid. Acad. Natur. Curios., 1694, Dec. III, Ann. I, Observ. 82, p.126–127, fig. An old gentleman after a chronic inflammation of the bladder discharged a few days before his death, through the urethra, a fatty ball containing a larva similar to those of Microlepidoptera, pale flesh-colored, with six legs, very active. The larva lived twelve days, and was then accidentally killed by closing the box in which it was preserved. The description of the case is somewhat odd, the figure

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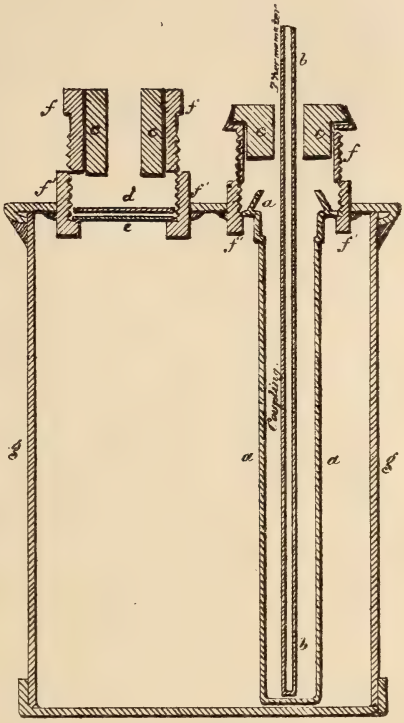
[1] While my paper has been passing through press, I have been able to examine two old original editions with the figures, which are not recognizable.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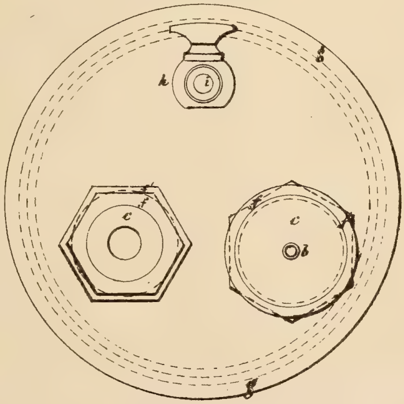

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HELIOTYPE

PARKER, SPONTANEOUS GENERATION.

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PROCEEDINGS

OF THE

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VOL. XX.

PART II. NOVEMBER, 1878—APRIL, 1879.

BOSTON:
PUBLISHED NOVEMBER, 1879.

bad, and not recognizable, as the larva shows large eyes, four pairs of legs along the body and a forked tail. However it represents the larva of an insect.

No. 5. M. F. Lochner. Disquisitio de vermibus cum urina excretis. s. l. et a. 4°. fig. 4. This work, quoted from Boehmer's bibliography, is not known to me, nor to Rudolphi. Lochner was a physician in Nuremberg in 1690. I cannot find what Boehmer has copied from; perhaps the citation is one of the many blunders in Boehmer's work.

No. 6. Dan. Clerici (LeClerc). Historia naturalis et medicalatorum lumbricorum etc. Genevae, 1715. 4°. Engl. transl., 1721. 8°. I have seen only the translation. He gives, p. 264, a very reasonable account of worms excreted with the urine; he quotes some cases related by older authors, and inclines to believe them to be untrustworthy. The pl. XIII (crinous hairworms, such as are excreted with the urine), taken from Etmueller, Ruysch and Leeuwenhock is wanting in the copy.

Fr. Ruyschii Thesaurus anatomicus. Amstelod., 1721. 4°. I, 32. A nobleman after a strong pain in the perinaeum discharged with the urine a large number of small bodies somewhat ovoid in shape and like grains, out of which developed small flies, figured pl. 3, fig. 5. It is stated in the same place, that he had seen similar ones in the urine of a woman, and he believes that the larvae had entered the bladder from outside through the urethra. The figure is bad, but shows the chrysalis of a fly and the fly itself. As there is an older edition from 1701 (Hope quotes I, 54) perhaps the case related by LeClerc is the same.

No. 7. Dan. Turner. Philosoph. Transact., 1725, XXXIII, 410. Two cases of insects voided by the urinary passage. The first case belongs to the intestinal worms (Strongylus), the second quotes an animal, probably an Oniscus, discharged by a lady. The short description is very insufficient. Rudolphi says, probably the larva of an insect.

No. 8. Dr. Werlhof. Commerc. litt. Nor. 1735, 282. Vermis. cum urina excretus. I have not seen this paper, but Rudolphi states that the worm is the larva of an insect.

No. 9. Mr. Veau de Launay, in Rozier Observ. de physique, 1792, XXXI, 158. Observations sur des vers rendus avec l'urine. pl. 1, fig 4. Rudolphi says the animal is *Oniscus asellus*. In the only copy here the plate is wanting. The description seems to me to designate the larva of Homalomyia. The sex of the patient is not given.

No. 10. Dr. Stringham, Professor in Columbia College. New York Medical Repository, 1805, VI, 262, and VII, 342. Reports the case of a lady whose sufferings were relieved and cured after the passage of a great number of nondescript insects, which he considers to belong to the genus Actinia. The very rough figures resemble an Oniscus.

No. 11. V. L. Brera. Memorie fisico-mediche sopra i principali vermi del corpo umano, etc. Crema, 1811. 4°. p. 106, pl. 1, f. 26–27. A new species of the genus Cercosoma had been discharged with the urine by a lady. Prof. Canali in Perugia, dissected and described it in Giornale letterario di Pisa. The unique type came in the collection of Brera and was described and figured. Bremser, p. 264, states that this worm is the well-known larva of *Eristalis pendulus*, and gives a copy of the figure on the title page. The proof that the larva, which was found in the chamber vessel, had been really discharged by the lady, is wanting. Bremser's remarks about this history are rather sarcastic. If all, he says. found in the chamber vessel must be considered as discharged, I have discharged in a sickness a pair of candle snuffers, which was found in the vessel, and which nobody would admit to have thrown into it.

J. G. Bremser. Ueber lebende Wuermer im lebenden Menschen. Wien, 1819. 4°. In this well-known and prominent work, chap. XII gives in an appendix the so-called Pseudohelminthes found in the human body but not belonging to the intestinal worms. The figures are given on the title page. In the same way (Brems., p. 261), Brera in his before quoted work, Part II, has treated the insects found in men as *Vermi metastatici*. Dr. Bremser's critical remarks for some species are very important.

C. A. Rudolphi Entozoorum sive vermium intestinalium historia naturalis. Amstelòd., 1808–10. 8°. 2 vol. In the bibliographical part of this celebrated work, I, 164, the published cases on larvae voided through natural passages of the human body are enumerated with short critical remarks. In chap. XXII, De insectis animalium parasiticis, p. 524, he gives his opinion about the cases in which it is professed that larvae were discharged through the urethra.

" Qui in vesicam urinariam veniant, me fugit, casusque plurimos, ni omnes, in quibus insectorum larvæ in urina repertæ dicuntur, ad praestigias referem. Larvæ aliaque insecta lotio misso facile illabi possunt, inde etiam omnium sæpissime, *Oniscus asellus* in eodem repertus est, quem medici nonnunquam pro verme aut insecti larva habuerant; matula forsan impura adhibita fuit, aut alius hinc inde error locum habuit."

No. 12. William Henry, M. D. Edinburgh Medical and Surgical Journal, 1811, VII, 147. Case in which the larvae of an insect were voided in the urine. A robust man aged about 62, frequently voiding gravel and once discharging a small calculus, complained of a stabbing pain about the neck of the bladder. Later he voided along with his urine the larvae of an insect, pretty closely resembling the common maggot. They were not only alive but vivacious, and besides those which were entire, the heads and bodies might be observed, detached from each other. Of the entire insects, he has frequently discharged three or four at once. Mr. J. L. Philips of Manchester examined the larvae and found them to be coleopterous and much like *Curculio nucum.* Three of the larvæ are figured of natural size and magnified; they are coleopterous.

In a note it is stated, that Dr. Monro, Jr., has met with a case precisely similar, and possesses specimens of the larvae in his museum.

No. 13. T. Bateman, M. D. Edinburgh Med. Surg. Journal, 1811, VII, 41, pl. An account of the larvae of two species of insects discharged from the human body. The larvae figured are two *Tenebrio molitor*, two *Homalomyia scalaris*, and a third perhaps of the same species. The larvae were discharged from the bowels, but Dr. Bateman quotes in his excellent paper also the cases published of larvae discharged from the bladder and concludes, " it must be acknowledged that the bladder is the least probable nidus for the larvae of winged insects."

No. 14. Leroux. Journal de Méd. Chir., Paris, 1806. A man suffering with nephralgia discharged with the urine larvae, which from the description belonged probably to Diptera. I was unable to compare this paper; it is quoted in E. F. Germar, Magaz. d. Entom., 1818, III, 418. A case is quoted in the same place from Howship, Tract. observ., on the disease of the urinary organs, London, 1816, 8°, treating of larvae discharged from the bowels. In Germar's Magazin, I, 134, the case published by Mr. W. Henry is briefly referred to after a notice in Göttinger gelehrte Anzeigen, Novbr. 7, 1812, p. 1779. The same article is again reprinted by J. Gistel in Bayerische National Zeit., 1836, no. 199, p. 826.

No. 15. Kirby and Spence. Introduction to Entomology, I, 239. (Peoples edit., p. 74.) A larva belonging to the Diptera, perhaps to the Tipulidæ, with which however it does not so entirely agree as to take away all doubt, was passed by a person (sex not given) in Ipswich with the urine. It was alive and extremely active. The larva is carefully described.

No. 16. Jer. Van Rensselaer, M.D. Silliman's Journ., 1828, XIII, 229. On a larva liberated with urine. The larva was discharged by a girl, and is, according to the short description, a coleopterous larva, probably that of *Tenebrio molitor.*

Rev. L. Jenyns. Trans. Entom. Soc., Lond., 1839, II, 152, pl. XV, f. 1–8. Notice of a case in which the larvae of a dipterous insect, supposed to be *Anthomyia canicularis*, were expelled in large quantities from the human intestines. The larvae, according to the figure and the description, belong probably to *Homalomyia scalaris*, and were discharged by an old clergyman in enormous numbers from the bowels. One passage in the paper induced me to suppose that sometimes the larvae were also discharged through the urethra, and for this reason the paper is quoted. However the fact is not stated in an unquestionable manner.

No. 17. Dr. Erismann. London Medical Gazette, 1837, XX, 846, (recorded after Schmidt's Jahrb. du Med. and Schweizer, Zeitsch., II, 1.) A robust young man was attacked suddenly by symptoms of the most acute inflammation of the bladder. After suffering intensely for five days, he found himself unable to pass his water, and this evidently from some mechanical obstruction in the urethra. Before a catheter could be introduced, he discharged a body of the size of a pea covered by purulent matter, which was found to contain a little beetle, *Ptinus fur*, which died directly on the exposure to the atmosphere.

The communication resembles those previously quoted from Gahrliep, and the final passage endangers even more the trustworthiness of the case.

No. 18. Dr. Schrader in Rust's Magaz., 1824, XIX, 487 and 1826, XXI, 26, describes the larva of a fly discharged with the urine as a snail. I have not seen the paper, which is related and corrected in Siebold's article on Pseudoparasites.

Rev. F. W. Hope. Trans. Ent. Soc., Lond., 1840, II, 256. On the insects and their larvae occasionally found in the human body. The tables were printed first in the London Med. Gazette, 1837, XX, April

15, p. 94–95; April 22, p. 142–143; April 29, p. 172; May 6, p. 406–207; May 13, p. 255; May 20, p. 286–287, and are reprinted in the Tr. Ent. Soc., with the addition of three columns : Station in life, Date of occurrence, Specimens preserved. Rev. Mr. Hope in some additional remarks proposes that the name Scholechiasis used by Kirby and Spence for all diseases occasioned by the larvae of insects, should be retained only for those arising from Lepidopterous larvae. The disease by coleopterous larvae he calls Canthariasis, and those by dipterous larvae, Myasis. On pl. XXII, f. 2–5, are represented various larvae from the human body contained in the musem of the College of Surgeons; fig. 2 is a worm, or at least no insect, f. 3, 4 are larvae of Homalomyia, f. 5 is *Oestrus hominis*.

The paper is important as the only list in existence and quotes 108 cases; seven of which belong to the urinary passages. The quotations in the paper are rather lax and not over correct. Dr. Koch in Ammon's Monatsschrift f. Medicin., 1838, I, 542, has given also a list of the larvæ observed in the intestines of men.

No. 19. R. Owen. Trans. Ent. Soc., Lond., 1840. Proc. p. 7, April 6. Report of a dipterous larva, distinct from Anthomyia and wanting the lateral filaments, several of which had been discharged from the urinary bladder of a patient.

Th. v. Siebold, in R. Wagner, Handwörterbuch d. Physiologie, 1844, II, 683, gives in his excellent article, Parasites, a chapter on Pseudoparasites. He speaks at some length on insects discharged from the bladder, and is strongly inclined to disbelieve the trustworthiness of the published cases. Prof. v. Siebold remarks, p. 688, that he possesses a larva of *Clerus formicarius*, communicated to him as an urine-worm, but it doubtless fell in the vessel by some chance.

No. 20. Dr. Cutler of Watertown, Mass. A larva of Homalomyia discharged with the urine by a country boy.

I by no means pretend that the list of authors enumerated by me presents a full record of all published cases, but I have gone through a large number of books and periodicals without finding more. Nevertheless a careful perusal of medical journals will doubtless furnish other published cases.

In four of the twenty recorded cases I was unable to examine the works myself. The value and trustworthiness of all the cases are very far from being equal. The two with Oniscus (Turner and Stringham) and the one with Eristalis (Brera), the case by Lochner of which nothing is known should be at once discarded. But even of the sixteen cases left one gives nothing more than assertion that the author observed cases similar to described ones. Werlhof is only accepted on Rudolphi's authority. Concerning the remaining ones only four (Tulpius, Ruysch, Gahrliep, Erisman) seem to be in so far less doubtful, as the animals were probably discharged in the presence of the physician. In Tulpius' case the patient and the recorder were both prominent physicians. In all other cases the patients only affirm that they have discharged the described animals.

Note. Since the above paper was read, Dr. Cutler has written to Mr. Henshaw, that the boy, induced by what Dr. Cutler had told him, examined the privy carefully and found several specimens similar to the one which he was supposed to have passed, and therefore thinks he may have been deceived in the matter.

The following letter from Dr. Hagen, read at a meeting of the Section May 22, 1878, was accidentally omitted from the Proceedings of that date.

"Last Sunday, May 19, on North Avenue, near Everett St., there passed just before the windows of the house of Prof. Hedge, while the family was at breakfast, a cloud of flying insects, dark enough to draw the attention of the family. They went out of doors and saw the cloud coming from the east, a part alighting on the garden steps. Some of the insects were preserved alive and sent to me and proved to be *Termes flavipes.*

"The phenomenon was more remarkable, and their attention more strongly called to it, by finding fifteen different kinds of birds following the insects so eagerly that even the presence of the family did not disturb them. Besides the common robins, bluebirds and sparrows, were others not seen before near the house. The birds caught the Termes partly in flight, partly on the ground, and the robins were finally so gorged in appearance that their bills stood open!

"I think such a flock of birds following an emigration of white ants — which is very common in the tropics — has never been noticed here. Perhaps the very early appearance of white ants (commonly they arrive in the middle of June) explains the hunger and eager persecution of the birds, as other insects are still rare."

General Meeting. December 4, 1878.

Vice President, Mr. S. H. Scudder, in the chair. Twenty-four persons present.

The following paper was read:

Traces of the Mediterranean Nations in the Northern Ocean. By Dr. S. Kneeland.

Dr. Kneeland called attention to a few specimens, most of which he had collected in Iceland, in 1874, as showing traces of the Mediterranean Nations in the region of the Northern Ocean.

It is interesting to follow the wanderings of nations by the arts of domestic life, which leave traces as permanent as those of language and customs, and are much more apparent to the ordinary observer and traveller.

The first specimens were of stockings from Fair Isle, a small rocky island midway between the Orkney and Shetland groups. The coast is so precipitous that a landing can only be effected in calm weather, and sometimes not for weeks. About three hundred people dwell upon it, the men getting a living by fishing, and the women by knitting; the hosiery is much sought after in Great Britain for its softness and warmth. In 1588 one of the ships of the Spanish Armada, (fitted out by Philip II. to conquer England) beaten by the English and buffeted by the storm, was wrecked on this island. Two hundred Spanish sailors were obliged to remain on the island all winter, causing great suffering both to the natives and to themselves from lack of food. The stockings exhibited are knit by hand in a very primitive way, from wool grown upon the island, and dyed in quaint colors by sea-weeds and mosses; though coarse they are very soft. The patterns and style of decoration are decidedly Moorish and Spanish; it is peculiar, and entirely unlike the fabrics of the neighboring Shetlands. It is highly probable that we see here the survival of patterns or ideas carried there by the sailors of the Armada.

The next specimens were of filagree silver work, such as for centuries has been made in Genoa and the neighboring towns; thence carried to Lisbon and to Brazil by Portuguese sailors. It is well known that Columbus was in Iceland in the latter part of the 15th century; and very likely the same ideas had been brought before to

Norway by Italian traders and by the Norse Vikings. This work is executed with great skill in Iceland at the present day.

The women of Iceland wear on the top of the head a circular piece of black cloth, with a long tassel of black silk hanging from a silver or gilded cylindrical ring an inch or two in length; this ring is precisely like those which the women of Cairo wear over the nose to hold the veil in place so as partially to expose the eyes. This *hufa*, as it is called, is much like that worn by the Greek women at the present day.

The Phrygian caps of the Faroëse men, and of the Icelandic students, remind one very forcibly of a similar head gear in Greece. The oriental customs of their ancestors, before the Aryan migration from Central Asia, from their isolation, have remained longer in Iceland than in the other and continental branches of the Scandinavian races. Among these may be mentioned the following: — They were early dwellers in tents; their form of government was patriarchal; the rites of hospitality were sacred duties; their travelling in long caravans of horses; the courtesy of their salutations; the use of milk curds for food, of dried fish for their cattle, and of dung for fuel; and the love of hearing in poetic form the exploits of their ancestors who established themselves in Spain, and in that way also obtained Mediterranean ideas which they carried to the North.

Another way in which southern ideas travelled northward was by the skalds or poets, who visited central Europe and even the East, reciting the martial deeds of the Scandinavians at the courts of kings, who were proud to have such learned and accomplished men in their service. They returned home laden with fame and wealth, bringing the various ideas of southern nations.

Peaceful farmers and herdsmen in the summer, in the winter and spring they became Vikings or sea-rovers, robbers on every plunderable shore. Western Europe, from Great Britain to Spain, was occupied or plundered by them, and they were so much dreaded that, in the prayers of the church at that time, was inserted the clause "from the fury of the Northmen, good Lord, deliver us." They obtained booty and southern ideas at the same time; but these bold sailors, the discoverers of Greenland and America, never lost their grand ideas of independence, trial by jury, the equality of woman before the law, and the other traits which make the energy, perseverance, and progressiveness of England and America — the Norse and not the Saxon traits are the hope of the nations of the Old World.

General Meeting. December 18, 1878.

Vice-President, Mr. John Cummings, in the chair. Sixty-nine persons present.

Dr. Hagen read a paper on the so-called "Carpet-Bug," *Anthrenus scrophulariae*, giving a humorous history of its appearance and depredations. To prevent the latter, he recommended that no new carpets be laid without a thorough beating, and that the edges be underlaid by tallowed paper and all crevices in the floors be well stuffed with tallow. The migrations of various other insects were referred to.

Dr. S. Kneeland remarked that twenty-five years ago there was not a house-fly in the Phillipines, but it had recently made its appearance and was increasing rapidly.

Some pictures of famous eruptions of Vesuvius, etc., presented by Dr. Kneeland were shown.

Section of Entomology. December 27, 1878.

Mr. S. Henshaw in the chair. Ten persons present.

The following paper was read:

SOME REMARKS UPON WHITE ANTS. BY DR. H. HAGEN.

I have been until now prevented by other more pressing work from finishing my study of the beautiful set of white ants from Jamaica, collected by Mr. H. J. Hubbard. As this study is now nearly finished perhaps some preliminary remarks may be of interest.

The eggs collected on April 13, were apparently only laid a short time before. The micropyle of Termes' eggs has not before been known. Near the upper pole of the egg, on each side, there are four to six rounded flat impressions; viewed in profile they are similar to a soup-dish, in the middle of this shallow funnel is a tube of smaller diameter going through the yolk-membrane in the direction of the egg-pole. These micropyli recall somewhat those of some Orthoptera, especially of Oedipoda.

The spermatozoa of the white ants are not yet known. The genitals of the mature male ants when swarming are still in a very imperfect state of developement, the testicula measuring only 3 mm. in diameter. For this reason the swarming white ants were formerly supposed by Guérin to be sterile forms. Copulation in the time of swarming outside the nest is therefore not very probable. It is sure that in swarming a kind of courtship so to speak takes place, as one always finds (this is the case with *T. flavipes*) a pair running together, the male having caught the female abdomen with its mandibles. The development of the male genitalia begins later, with the swelling of the abdomen, and these males commonly called kings, are the only forms in which the testiculi had been observed in 1850 by myself.

Dr. Fritz Müller says concerning the spermatozoa that the Termes do not possess the filiform kind of other insects, and that he has found in the testiculi of the mature kings of several species pale rounded bodies, some larger, (0.008 mm. diam. in *Eutermes vernalis*) seemingly without nucleus and without enveloping membrane, which swell in water twice their size; or smaller bodies 0.002 mm. diam., strongly refracting light. The first he presumes to be the fructifying parts of the sperma, but they are so pale and their form so little defined, that he could not say whether they were to be found in the winged males, nor could he find them in the vesicula seminalis of the queen or those of the winged females. In the winged males of the Eutermes which build the 'negro-head' tree nests they were probably still enclosed in cells.

I have been able, however, in some eggs to see distinctly a bunch of filiform spermatozoa inside the micropyle, and in one case I was able by pressure to bring them out in the same manner as described by Leuckart for the pupipara. Perhaps they are developed only very late.

The yolk-membrane is very often separated from the chorion, even evaginating through places where the chorion is broken. Very often the yolk-membrane shows a series of transverse folds, at regular intervals, perhaps the effect of the alcohol. The yolk is composed of very large globular cells. I have found in other eggs embryos in every stage of development, and propose later to give some details. There are about a dozen queens before me, 25 to 20 mm. in length; with one were also in the same cell two males and two females, all wingless, but the abdomen not yet swollen.

Concerning the curious form of the nympha with short wing cases, only covering the first two dorsal segments, instead of five as in the ordinary nympha, I found only two, one male and one female among the thirty sent by Mr. Hubbard, and collected in the same nest April 13, when the swarming had begun. In a lot of *E. Rippertii* colected by Osten Sacken in February, there were only six nymphae with short wing cases, and none of the common form with long wing cases. This fact agrees very well with Müller's opinion, that the short winged ones are supplementary queens, only used when no others are present. He observed the laying of eggs by such nymphae.

A most remarkable discovery by Mr. Hubbard is that the young are fed upon prepared food, which is stored up in the form of very hard and tough rounded masses, evidently composed of comminuted wood. These masses, varying in size from small grains to lumps larger than a man's head, are loose and without any connection in the middle of the nest, and are hollowed out by the young termites from the under side. The masses are yellowish, of very fine structure, like some confectionery, and are so light that one lump nine centimetres long and four and a half broad weighs only two and a quarter ounces. As Mr. Hubbard states that some nests contain many pounds weight of them, it can be understood how large the amount is of such masses prepared for the progeny. Prof. Hill has kindly made for me a chemical examination which proves that in 100 parts they contain only 1.91 ash, (inorganic matter) when dried at 120° degrees, and 9.79 water. Therefore the organic matter is 88.31 parts. These lumps float in water, while the other parts of the nest do not. The substance of the nest contains 11.8 water; 17.1 inorganic matter, and 71 organic vegetable matter. Therefore the lumps show a marked excess of organic matter.

Besides these lumps there is prepared for the young white ants another kind of food, probably for the first period of their life. Among the eggs was found a large number of very small and very hard round bodies, recognized by Prof. Farlow as the sclerotium of a fungus. Some of them were apparently just ready to burst and produce the fungus. I should state that I do not know of a similar proceeding for nourishment of the progeny by any other insect or even any other animal.

When I learned these interesting habits I remembered that Mr. Nietner some twenty years ago communicated to me just the same facts, observed in white ants in Ceylon. He speaks of the lumps, and describes them in a similar manner, and of a numerous microscopic fungi, the heads as large as the heads of pins, composed of small pearls, growing in groups with a network of roots, resembling crystals of ice or silver. Later I also remembered that a hundred years ago the missionary Koenig spoke of similar fungi in the nests of white ants in Tranquebar. I myself raised them in Königsberg from portions of the nests sent to me by Mr. Nietner, and had them growing for nearly a year.

General Meeting. January 1, 1879.

Prof. A. Hyatt in the chair. Eighteen persons present.

Mr. L. S. Burbank made some remarks on the chronological evidences contained in certain rock deposits. He also described the structure of Rollstone Hill, near Fitchburg, Mass., and showed some fine cut beryls from the same locality.

General Meeting. January 15, 1879.

The President, Mr. T. T. Bouvé, in the chair. Forty-two persons present.

After calling the meeting to order the President said:

Since we last met, Death has once again entered our circle and borne from us one of the oldest and most highly respected of the active members of the Society, Dr. J. B. S. Jackson.

To those of you who have not been members for more than the last decade or two of years there can be but little appreciation of the feeling experienced by those of us who were contemporary, or nearly so, with the founders and early members of the Society, when one of their number passes the limit that divides the seen from the unseen. Among these were men of noble characters and impulses, to be associated with whom was to be impressed with such sense of their great excellence and purity of purpose as no subsequent experience through life could obliterate. Claiming but little knowledge of Natural History, but strongly appreciating the importance of its study both for themselves and the community, they came together for mutual help in the acquisition of knowledge and to combine their efforts for its dissemination, modestly expressing in the preface to the first number of the Journal "that having but small claims to the character of Naturalists, they nevertheless are desirous of contributing something to the common stock of information."

In the greater light of the present day, and reflecting upon the little aid obtainable by them through books or collections, we may well exclaim, Noble men! Simple seekers of truth, not only for your own good but for that of all others; you grandly did your work! And so they did. The many volumes of their papers and proceedings attest this: the State reports upon the geology, the invertebrate animals, the fishes, the insects injurious to vegetation, the trees and shrubs of Massachusetts; all by early members resident or corresponding, speak unceasingly of the value of their labors. And the magnificent developement of the Society until it has become what it now is, with its great collections and its wide felt influence, — how much of this is due to their early strivings who shall say? Certainly all is but the fruition of their hopes and desires.

Among these early members were Dr. Benj. D. Greene, an accomplished botanist and the first President of the Society; Dr. Augustus A. Gould, the author of the Report upon the Invertebrates of the State and who became one of the most able general naturalists of New England; Dr. D. Humphreys Storer, the author of the very valuable Report upon the Fishes of New England; Dr. Amos Binney, an accomplished conchologist, afterwards President; Dr. Chas. Pickering; Mr.

Geo. B. Emerson, author of the great work upon the Trees and Shrubs of the State; Dr. Martin Gay, an able chemist; Dr. Chas. T. Jackson, well known as an accomplished chemist, mineralogist and geologist; Mr. Francis Alger, the author of a valuable work on mineralogy; the Rev. Dr. T. W. P. Greenwood, who seemed more divine than human in the loveliness of his character; Dr. T. W. Harris, author of the Report on Insects injurious to Vegetation, and last to mention, though by no means the least in his influence upon the affairs of the Society and its character, Dr. J. B. S. Jackson, whose loss we now deplore.

The particular investigations of Dr. Jackson were generally not of a nature to bring him prominently before the Society as an instructor in any branch of Natural History, his labors being largely confined to a class of subjects more generally interesting to students in pathology. Yet the Journal of the Society presents to us several papers of great value to naturalists, and the Proceedings contain remarks made by him at various times embodying much useful information.

Dr. Jackson was elected a member in the autumn of 1831, the Society having been incorporated the previous February.

In 1837 he read before the Society a paper which was published in the Journal, giving an anatomical description of the Gallopagos Tortoise, which was a valuable contribution.

In 1842 the Journal gives an account read by him of the dissection of two adult dromedaries, male and female.

In 1845 there is in the Journal a paper upon the dissection of a spermaceti whale and three other Cetaceans.

Of his remarks made from time to time upon scientific subjects and published in the Proceedings of the Society, may be found some of interesting character upon the teeth of *Delphinus globiceps*, upon fossil bones of the *Mastodon giganteus* from Schooley's Mountain, N. J., and upon bones from Indian tumuli.

As said before, Dr. Jackson's most important work was in pathology rather than in natural history. He became Professor of Pathological Anatomy in the Medical School of Harvard University in 1847, and was ever after a most diligent laborer in its interests, investigating with great patience and with keenness of observation arising from constant experience, the morbid effects of disease upon the organs, and writing out fully and carefully the results of his examinations, which have been of invaluable service in the cause of medical science. Much of his work for many years was in the building up the Cabinet of the Society of Medical Improvement and its arrangement for study, and in the care and arrangement of the Warren Museum. Of these two fine collections Dr. Jackson published descriptive catalogues, containing much matter of great interest to students in medicine and surgery. Others can write and speak more wisely and instructively of these great services than can the writer, who has only been associated with him in our Society of Natural History and as a personal friend. His work for the Society has been spoken of, but what he did for it in labor and through publication was but a small part of the aid he was able to render it. No member ever felt more interest in its welfare, and if this was not manifested to the same degree in actual devotion to work upon its collections and to investigations in Natural History subjects, it was only because his valuable time was preoccupied by the duties owed to his official position. He has always been in the habit of attending the meetings of the Society, and always exhibited a strong desire that they should be made as instructive as possible to younger members, to such particularly as were entering the paths of science. He was ever urgent, too, that all the specimens of the collections of the Society should be so distinctively and fully arranged and labelled that all visitors might clearly understand their character and relations. He indeed sometimes felt impatient that this was not already accomplished, so important did he regard it as a means of education; though he did not fail to recognize that with the means at the Society's disposal this work must necessarily be slow. He lived to see great progress towards the realization of his wishes in this respect, and if his life had been spared a year or two longer his fullest desire might have been satisfied.

One marked peculiarity of Dr. Jackson was his great interest in the advancement of worthy members to positions of honor and usefulness in the Society. Entirely free from any ambitious desire for office himself, he wished to gratify the feelings of those whom he thought deserving and to whom position might be an inducement to exertion. It is pleasant to dwell upon the special characteristics that made our departed friend a useful member of the Society, but with what additional pleasure can we recall the traits that made him the delightful companion, the beloved friend, the dear husband and father; that led all with whom he came closely in contact to regard him with affection and respect. Simple, unostentatious, true in all the relations of life, honest in the expression of his convictions, and pure in heart; he lived amongst us a blessing to his friends and the community, and has passed away leaving only the most tender memories. May we be helped by his example to live and do our life's work so that it may be said of each of us when we likewise depart what may be truly said of him: Those who knew him the best loved him the most.

At the close of the President's address, Dr. D. H. Storer said:

Mr. President: — I rise merely to express my thanks for your faithful and most appropriate remarks respecting our departed friend. I should have regretted not to have heard them. I rejoice that nothing ever occurred to alienate him from the Society — that he continued to feel the same interest, and to evince the same zeal in its prosperity as long as he was with us.

Jackson and Wyman I always associated together — in my heart they were one — ever faithful and true.

Again I thank you, Mr. President, for your heartfelt tribute.

The meeting then proceeded to the election of Associate Members, and the following candidates were elected: — Dr. C. A. Holt, Dr. Clifton E. Wing, Dr. A. N. Blodgett, Mr. Charles E. Pratt, Dr. John Dixwell, Mrs. A. L. Boardman, Miss M. A. Wilcox, Mrs. S. T. Hooper, Mr. Roland Hayward, Miss E. D. Boardman.

The following paper was read:

NOTES ON CERTAIN EVIDENCES OF A GRADUAL PASSAGE FROM SEDIMENTARY TO VOLCANIC ROCKS SHOWN IN THE BRIGHTON DISTRICT OF BOSTON. BY N. S. SHALER.

In the following paper I desire to call attention to certain phenomena observable in the rocks locally known as the Brighton Amygdaloids. It seems to me that these rocks afford evidences that the shales and conglomerates of the Roxbury series pass at certain points into an amygdaloidal trap which has been ejected through the overlying beds. While I do not think that the evidence warrants a positive assertion of such a change, I do not see how the facts are consistent with any other hypothesis.

The features to be observed in this very interesting district are so varied and important, that it will be necessary to give a rather extended account of the rocks found there. The noteworthy features are connected with either of two questions, the history of the "country rocks" or that making up the principal part of the rocks in this locality, and the history of the several local dykes which make their way through its mass.

Even a cursory inspection of the *country rock* will show that it differs essentially from any of the ordinary rocks found in the vicinity of Boston. It is best seen at the pumping house quarry on Cambridge St. The outward appearance of the rock is quite peculiar, it is of a greenish red color when shown in fresh fractures, and though it oxydizes in the weather, retains a part of its peculiar hue even when covered by lichens; throughout the mass we find a great number of spots of a whitish color; a little close study will make it clear that these spots were originally cavities, into which their present contents have been carried by the action of water. The magnifying glass, and at times the naked eye, show the successive coats of material which were deposited as the holes were filled up. Often as the filling went on, there came a change in the materials borne by the infiltering waters, so that the inner spaces of the cavities contain other substances than the outer circles. In localities near the pumping house quarry, especially in those on Allston Street near the carriage factory, this amygdaloidal rock shows the cavities partly filled with a reddish jaspery substance. The upper level of this filling is a plane; above it to the top of the cavity subsequent infiltation has brought in other substances. At other points near the small cemetery on Washington Street, about four hundred metres south from the pumping house quarry, and at the quarry on North Beacon Street, thirteen hundred metres nearer Boston, we have yet another set of facts which serve to show more clearly the history of this peculiar rock. We see in these localities a mass of conglomerate essentially the same as the Roxbury pudding stone, only the pebbles and the cement have been greatly affected by heat so that the whole is more fused together than in the ordinary forms of that conglomerate — looking closely we see that the matrix of the pebbles and to a certain extent the outer parts of the pebbles themselves are filled with cavities in which similar amygdules have been formed. With care and with favorable conditions of the quarries, the observer may trace the stages of this transition, from the faintest beginning of this structure in rocks which are distinctly conglomerates, into rocks where the blebs have been so completely developed that every trace of the original pebbly structure is now lost, and the mass converted into the amygdaloidal trap. The trained eye also recognizes that as the blebs increased in the pebbly mass it became endowed with a certain plasticity and was squeezed out of its original position. The direction in which it moved is also traceable by the elongated forms of the blebs or of the amygdules which have been deposited in them.

By carefully following these lines of evidence the student will be forced to conclude that the history of these amygdaloids is about as follows: In the first place the pebble beds and slates of the Roxbury conglomerate series were laid down to the thickness of several thousands of feet of strata, on them came many thousand feet of other beds which once covered this region but have since been worn away. In yet later times the mountain building forces crumpled these rocks into lofty mountain chains which have since been worn down to their very roots. The deep burial of the conglomerate series brought a great heat into them; they were raised to a temperature much exceeding that of boiling water, possibly to a temperature of one thousand degrees Fahrenheit or more. Every part of these rocks contained small cavities in which water was stored away; these microscopically small water spaces were especially abundant in the matrix which inclosed the pebbles, but they occurred also in the pebbles themselves though less abundantly. When the heat to which these rocks were subjected by their deep burial beneath strata of subsequent deposition had exercised its full effect upon this mass, we may conceive these drops of water were straining to burst their bonds and take the state of vapor. In this state the rocks softened by heat, and under the strain arising from the aggregate pressure of these infinitely numerous steam vesicles, it only needed that some fissure penetrating from the surface, after the manner of the faults which rive the rocks in every disturbed country, should give a possible line of escape for the compressed vapor, to make the beginning of a volcanic eruption. Every time such a fissure opened the least prospect of relief these confined gases would blow the softened rock up into the crevice, as the rock rose the vesicles would expand under the relief from pressure to make the bleb-like openings in which the amygdaloids have been deposited. If the fissure led to the surface we would have had a true volcanic eruption; if the crevice did not rupture all the overlying rocks we should have only a dyke ejection. Although the exposures here are few and small, a little careful looking will show the observer many evidences of the steps by which this gradual passage of sedimentary rocks into lavas is brought about; in the quarry on North Beacon Street, just east of the crossing of Harvard Avenue, there is evidence that some of the larger boulders of the conglomerate have escaped the complete destruction arising from the expansion of the contained gases. In the unquarried rocks near the small cemetery on Warren Street, between Breck and Cambridge Streets, the change of the rock from the expansion of the gases appears to be just begun and the air blebs were only found in the matrix which holds the pebbles, not having extended to the pebbles themselves. At the quarry on Allston Street between North Beacon and Warren Streets, in the pit of which a small carriage factory has been built, there is a mass of this rock which gives some curious evidence as to the history of its movements. At this point many of the gas cavities have been in part filled in with a reddish rock resembling jasper, these reddish deposits have been evidently laid down from water by gravitation, as they fill only a portion of the space and are bounded above by distinct plane surfaces which are parallel in the various neighboring cavities.[1] These planes which bound the reddish filling of the blebs are now tilted at high angles to the horizon, and show that the mass has undergone extensive movements since its conversion into trap.

The general character of this volcanic mass makes it seem probable that it was a true volcanic ejection, poured out towards the old land or ocean floor, and not an ejection stopping short of the surface, as is the case with most of our dykes. It is not likely, however, that the portion now left here represents the lava extruded from the volcanic vent; it is probable that we have only the material filling the fissure up which the volcanic matters travelled on their road to the surface.

The interesting group of rocks considered in this paper occupies only a small space in this region, its form is that of a strip some hundred feet wide, and extending from near Bigelow Street on the west, to near the junction of North Beacon and Chester Streets. It may extend somewhat further to the east and west, but if so it is masked by the coating of drift that covers it.

At the pumping house quarry, and that near the junction of Chester Street and North Beacon Street the amygdaloid is seen to emerge from below, a series of thin bedded compact shales following the plane of their bedding. The exact contact of the two formations, however, is not seen at either place; at the former of these localities the contact of the amygdaloid with the lower lying thick bedded slates is seen in the wall of rock that borders the sidewalk a few feet to the west of the pumping house. We there see that the slates are little changed by their contact with the amygdaloid, showing that the mass was not very much heated at the time of its ejection. The position of this amygdaloid in an apparent interbedded relation to the over and underlying rocks, would at first sight lead the observer to suspect that it was what is sometimes called a contemporaneous trap, *i. e.*, a mass poured out on the sea floor and afterwards covered by a later series of deposits; it seems more likely, however, that the ejection of the amygdaloid did not take place until the rock had been upheaved at a high angle, so that the line of easiest escape for the molten rock was along the planes of bedding — that is, it was easier for it to rupture its way out in this line than across the close textured bedding planes.

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[1] These infiltrations of jasper were first noticed by Mr. W. M. Davis, Jr., whose interesting observations on this and other structural peculiarities of these rocks are as yet unpublished.

Although there are thousands of dykes exposed in Eastern Massachusetts, there are very few that show any distinct traces of air vesicles in their structure. The mass in Brighton and one in Hingham being the only cases known to me where the vesicular character is distinctly indicated; both these masses seem to me pretty clearly eruptive in their origin, though by some excellent observers they are regarded as stratified rocks altered in place.

It seems to me that this hypothesis of the passage of sedimentary beds into lavas, to which we are led by the inspection of the phenomena of these amygdaloids, is connected with all we know of the action of volcanoes in eruptions. Such eruptions consisting essentially in the escape of the gases of water and other volatizable substances which have been buried in sedimentary deposits, the generation of the gases must at first give rise to blebs such as we find in these amygdaloids which work their way through the mass to the point of escape.

The absence of similar vesicles in the other more common dykes in this neighborhood is perhaps to be explained by the assumption which is verified by their other phenomena, that the ordinary dykes represent movements of lavas which have taken place in channels which did not communicate freely with the surface, and were under such great pressure that their volatilizable substances could not pass into the state of vapor.

I should say that it seems to me likely that under the term amygdaloids we include rocks having a very diverse origin; those where the almond-like segregations arise from the infiltration of gas cavities, and others where the cavities are formed by a process of decay; some at least of the latter class are probably true stratified rocks which have never been melted.

Section of Entomology. January 22, 1879.

Mr. Edward Burgess in the chair. Thirteen persons present.

Dr. H. Hagen read the following letter to Mr. Henry Edwards from Mr. Dean, about flies in a petroleum lake, Santa Cruz Co., Cal.

The habitat of these flies is at the south eastern corner of Santa Cruz Co., Cal. The immense coast range here ceases at or near the right bank of the Pajaro River, the river passing by the mountain at this point without any sudden fall. The mountain is composed of a very new sandstone filled with shells, many of which yet lie in the stream. There is also a whitish shale, a little piece of which I inclose, which contains fossil shells different from those of the sand stone; this shale I suspect, without having examined it, to be in some degree infusorial.[1]

At the immediate foot of the mountain is a lake of probably twenty to thirty acres area. In winter and spring this lake is full of water which becomes more strongly alkaline by evaporation toward the latter end of summer when the lake becomes nearly dry, its bed being then covered several inches deep with white layers of carbonate of soda.

On the north side of the lake are copious petroleum springs which continually pour out their tar, and this drying has formed masses of asphaltum overlying the soil and running down into the lake. The petroleum forces passages through this asphaltum forming little pools of about the consistence of molasses.

The flies in question exist in myriads, and appear to breed upon the water plants covering the surface of the lake, which are left incrusted with the salt and covered with the empty shells of the insect. The flies sent you were caught with one sweep of the hat, probably more than a pint were so caught. They were sitting upon the petroleum and piled up upon one another in vast numbers just like flies upon molasses, those underneath die and become imbedded in the petroleum and are succeeded by others which in turn are pressed down into the liquid tar by those above. On approaching them they rise in a cloud about two feet above the petroleum, and on being unmolested return and settle upon it. The dead flies lie several inches deep above the liquid petroleum.

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[1] I was not able to find infusoria. Dr. H.

NOTE BY DR. HAGEN.

The interesting fact that some Diptera appear in immense numbers as is often the case with Ephydra, is repeated by some Chironomidae. *Hydrobaenus lugubris* was observed near Vienna (Wien. Z. B. Gesch. VIII, 421), by Kollar on the border of water inundating a meadow. A space one thousand feet long and six feet broad was covered an inch high by living insects of this species, propagating or laying eggs. As the insect is only one line long, and as about one thousand would make a cubic inch, Kollar calculates the number must have been some 2,500,000,000 of specimens. I had observed the same fact under entirely similar conditions in eastern Prussia (Stett. Zeit., 1860). As the meadows are dry in summer, the eggs must have a very great vitality.

The species from California belong to the genus Ephydra and is probably a new species. In Osten Sacken's old catalogue, only nine species are mentioned or described, six from Hudson's Bay, two from the West Indies, and one from Mexico, all unknown to me, and not represented in the collection. O. Sacken's and Loew's collections have only four species, one from the Mono Lake not named. I do not know *E. halophila* Park., (this name was long ago used by v. Heyden, though his species is now considered the same as *E. salinaria* Bouché), and I cannot find a detailed description except the figure and the few characters in his guide, which proves that the Californian species is different. Dr. Packard has later described *E. gracilis* from Great Salt Lake, and *E. californica* from Clear Creek Lake, Cal., only larva and pupa. As he states them to be identical with those from the Mono Lake, of which species the collection of the Cambridge Museum possesses all stages, I can say that the species from Santa Cruz Co., is a different and smaller one. But I confess that I am unable to find all characters described by Dr. Packard in the larva of his *E. californica* in the larvae from the Mono Lake, where I see, for instance, clearly the spigot-like stigmata, described by Loew, which Dr. Packard stated he was unable to discover. Therefore until the identity of the Santa Cruz Co. species with *E. californica* is proved, I shall believe it to be a new species.

Dr. Hagen also showed figures of the larvæ of *Thyreus Abbotii*, one showing a specimen so largely spotted with green, as to make this the predominant color, and remarked n the variations in the coloring of Sphingid larvae.

General Meeting. February 5, 1879.

The President, Mr. T. T. Bouvé, in the chair. Forty persons present.

Dr. S. Kneeland read an essay on the Monstrous in Art, or the relations of Zoology to Symbolism, illustrating his remarks by specimens and photographs of various celebrated pictures and statues.

The following paper was read:

On the Occurrence of Fossiliferous Boulders in the Drift of Truro, on Cape Cod, Mass. By W. O. Crosby.

The extreme scarcity, amounting to almost complete absence, of distinctly fossiliferous rocks in this section of New England, causes a high degree of interest to attach to all new discoveries, even when these consist of erratics, as in the present case. The facts in this instance, however, possess a peculiar interest, since they point to the extension of the Tertiary deposits of our Atlantic sea-board to a point farther north than they have before been certainly known to occur. Briefly stated, the facts are these: boulders and pebbles containing Tertiary fossils have been found in the modified drift of Truro in this State. The credit of the discovery of these fragments belongs solely to Mr. Warren Upham, of Nashua, New Hampshire, a zealous and successful student of the surface geology of this and adjacent regions; and the following account of the finding and mode of occurrence of the material is extracted from notes which he has kindly placed at my disposal.

The fossiliferous pebbles which occur in the drift of Truro were first noticed by Mr. David F. Loring, keeper of the Highland Light, who had collected and given away a few pieces before my first visit to Cape Cod in November 1877. At that time he had no specimens left, and limited time prevented any search for them. In June last

I spent two or three hours in hunting for these pebbles, obtaining five pieces which were six inches to a foot in diameter, with several others of smaller size. One of the large pieces which had a good exposure of the enclosed shells was presented to the Boston Society of Natural History. In October I again visited the locality, making a longer search than before and finding about a dozen pieces of the shelly rock, most of them less than eight inches in diameter, which were also presented to the Society and placed in your hands for determination. The cliff from which these pebbles were obtained is on the east side of Cape Cod, in Truro, one-half mile south of the Highland Light. This bank is some twenty feet higher than that on which the light-house is built, being about one hundred and fifty feet above the sea. It consists of sand and gravel, the pebbles being of all sizes up to a foot in diameter, mostly rounded by water wearing, but a part of them angular, especially the large pieces, some of which may be two feet long. The foot of the cliffs here is guarded from the waves by several rods of sea-sand covered by beach-grass, so that the gravel and sand have fallen down in a steep slope strewn with pebbles, among which these pieces of shelly rock are found. They occur rarely for twenty or thirty rods along the face of the cliff, at all heights up to one hundred and twenty-five feet, being most abundant between seventy-five and one hundred feet above the sea. Like the other pebbles, most of these pieces are more or less waterworn, some of them being rounded on all sides, indicating that their modes of transportation and deposition were the same; but the stratification of this cliff is obscured by falling down, so that we do not here find these fossiliferous pebbles actually imbedded in an undisturbed drift deposit.

Before gathering any of these specimens, however, I had found a fragment of similar shelly rock four miles further south, in a layer of gravel five feet thick overlaid and underlaid by regular strata of sand. This gravel was at a height of thirty feet above the sea, with one hundred feet of sand and gravel above it, evidently occupying its original place in the extensive deposits of modified drift which form this part of Cape Cod. Examination along the whole line of cliffs which extends more than fifteen miles on the east side of this peninsula, from Nauset Lights to High Head in the north part of Truro, composed entirely of gravel and sand with local deposits of clay, failed to discover any other fragments of this rock, except that two bits of it were found in a freshly exposed section of sand and fine gravel, a half mile south of the cliff from which the large specimens were obtained. The scarcity of this peculiar rock has been indicated by the statement that a search of three or four hours was required to find a dozen pieces of it, where the whole bank one hundred and fifty feet high was plentifully strewn with pebbles. It is not improbable, therefore, that fragments of it may occur sparingly throughout this whole series of cliffs, although I detected it only in the places mentioned.

The rock is mainly a firm, massive, white, calcareous sandstone, effervescing freely with acid, and yet, to the eye, principally composed of rounded grains of transparent quartz. The fossil shells are always abundant, and in many cases form a large part, nearly the entire mass, of the rock, which then becomes a shelly limestone; but the contained fossils are not the source of all the calcareous material, for Mr. Upham has found in this rock a distinct lime-stone pebble about half an inch in diameter. Minute grains of glauconite are freely disseminated; and this mineral not unfrequently fills the molds formed by the dissolving out of organic remains; but it never forms a prominent feature of the rock. Vestiges of lignite and grains of iron oxide are also sometimes observed. With the exception of the lignite, the organic remains are all animal, principally molluscan, bivalves predominating; and, although I have seen only a few small masses, probably less than fifteen pounds, of the rock, fully twenty-five species are represented, proving a varied as well as an abundant fauna. The large shells are usually in a fragmentary state, and this, together with the coarseness of much of the sand, is a plain indication that the materials did not accumulate in tranquil water. In many other cases, too, the original shells have been removed by solution, leaving nothing but imperfect molds or internal casts, though sometimes replaced, as above stated, by green sand; all of which adds to the difficulty of accurate identification.

I have been able to determine satisfactorily only a small proportion of the species. None of these are recent, but appear to be mainly characteristic Eocene forms. One large Lamellibranch, although represented only by the mold of a single valve (the right), is certainly *Venericardia planicosta* Lamk., now known from the Lower Eocene of Virginia. There appear to be two other species of this genus. One of these, a minute form, is probably *V. parva*, described by Lea from the Eocene of Alabama; while the other, one specimen of which shows the valves united, is very near the young of the common species *V. alticosta* from the same formation. There are at least three species of Ostrea; the smallest, averaging about an inch long, appears to be identical with *O. divaricata* Lea, from the middle Eocene of Alabama, though possibly the young of *O. sellaeformis* Con., a characteristic form of the Lower Eocene of Alabama, South Carolina and Virginia. Another species, occurring principally in fragments, and the most abundant fossil which the rock contains, may be the common and little characteristic *O. virginiana*. While the third form, which is represented by a single fragment, must have been very large, the shell being at least two inches thick, and consisting of laminæ or layers one-eighth of an inch thick. A smooth and regular Anomia about seven-eighths of an inch in diameter resembles *A. tellinoides* Morton from the Cretaceous of New Jersey, Alabama and Mississippi; and a small Plicatula with about eight very regular, triangular ribs is certainly near *P. filamentosa* Con., from the Eocene of Alabama. A small, smooth, circular and abundant Pecten is probably *Camptonectes calvatus* Con., heretofore known only from the Middle Eocene of South Carolina. Pectunculus-like shells, too fragmentary for certain identification, are near, if not the same with, *Axinæa staminea* Con., Eocene, Alabama. Another member of this family resembles the Miocene *Striarca centenaria*. Among the shells which I have only been able to determine generically are also a thin, circular Cardium about one and a half inches across; at least two species of Yoldia or Nuculana; a small Corbula; and of Gasteropods, several small Turritella-like species and a small Natica; and besides these there are numerous minute forms of both univalves and bivalves of which I can make nothing at present. Echinoderms are represented by several slender and sharp-ribbed Cidaris spines; and Cœlenterates by a simple, cylindrical, Galaxea-like coral, with cells five to ten mm. in diameter, but differing from the genus named in the curious reticulation and coalesence of the vertical partitions. Two cells only have been observed, and these are separate.

Although much yet remains to be done in the way of identifying these fossils, yet the few forms that I have made out seem to place the Eocene age of the material beyond reasonable doubt. Mr. Upham's account of the way in which the fragments occur, it will be observed, shows at once that they are of pre-glacial origin, and that they have not been transported by human agency, but are genuine drift material; from which we may infer that the parent bed, if not entirely swept away, now forms the floor of Massachusetts Bay somewhere to the northward of Cape Cod.

It is interesting to compare this evidence of submarine Tertiary deposits in this latitude with that noted by Prof. Verrill, in the American Journal of Science for October last, as obtained from George's Bank and Grand Bank. The rock from the banks is similar to that from the Cape, though usually darker colored, being more argillaceous; but the widest difference is with the fossils, which appear to show little agreement, while, according to Prof. Verrill, a large proportion of those from the banks are recent species. It will be observed, too, that the evidence of pre-glacial age is less conclusive in the case of the material dredged on the banks, than for that collected on the Cape.

Dr. T. Sterry Hunt made a communication on the pre-Cambrian rocks of the British Islands.

Dr. Hunt described his observations made in the summer and autumn of 1878 among these rocks in Carnarvon and Pembroke shires, Anglesea, Argyleshire and elsewhere in Scotland, and also in the north and the south-east of Ireland. He had farther examined, in company with Profs. Gosselet and Renard, the rocks of the Ardennes along the valley of the Meuse. In Wales he had the company and guidance of Dr. Henry Hicks. Dr. Hunt insisted on the complete parallelism presented both in stratigraphical succession and lithological characters (Dimetian) between these pre-Cambrian rocks — particularly in Wales, where they are best displayed — and the pre-Cambrian rocks of North America. The most ancient rocks there, provisionally named Dimetian by Hicks, and chiefly gneisses, the speaker regarded as Laurentian. The quartziferous porphyries, at first united with the above, but now separated by Hicks, with the name of Arvonian, are the great orthophyre or petrosilex series, which he has described in various parts of North America as lying at the base of the Huronian. These, in Wales, appear separated by a stratigraphical break from the Pebidian rocks of Hicks, which are Huronian and, as displayed in Anglesea, had been by the speaker, many years since, referred to the Huronian series. They are also well seen in Argyleshire and in the north of Ireland on Loch Foyle. The Dublin and Wicklow hills of Ireland he regarded as Montalban, of which they have all the characters.

The crystalline rocks of the Ardennes have also many of the characteristics of the Huronian series, but the speaker regarded it as a question how far the Taconian, (Lower Taconic, Emmons) which has lithological affinities with the Huronian, may be included in the Ardennian series of Dumont. These rocks have been variously called altered Devonian, Silurian, and Cambrian. Some schists at Haybes in this region have lately yielded *Oldhamia radiata,* of which the speaker had secured fine specimens.

The thanks of the Society were voted to Mr. Chas. S. Sargent, for some fine trilobites from Ohio.

General Meeting. February 19, 1879.

The President, Mr. T. T. Bouvé, in the chair. Thirty-one persons present.

Mr. H. G. Kittredge read a paper on the natural history of cotton, describing the plant in all its stages, and its varieties in the United States and their geographical distribution.

General Meeting. March 5, 1879.

The President, Mr. T. T. Bouvé, in the chair. Thirty persons present.

Messrs. Frank S. Collins, Lewis W. Tappan, Jr., Col. T. W. Higginson, Dr. J. C. Merrill and Mr. J. S. Diller, were elected Associate Members.

Dr. E. L. Mark, Messrs. Wm. M. Davis, Jr., and Fred. Habirshaw were elected Corporate Members.

Wm. Boyd Dawkins, of Manchester, England; Wm. Henry Flower, London; Andrew C. Ramsay, London; Archibald Geikie, Edinburgh; James Hector, Wellington, New Zealand; Guido Cora, Turin; Franz Ritter v. Hauer, Vienna; Ferd. v. Hochstetter, Vienna; Ferd. v. Richtofen, Berlin; Hans Bruno Geinitz, Dresden; Ludwig Rütimeyer, Basle; and Harrison Allen, M. D., Philadelphia; were elected Corresponding Members.

The following papers were read : —

SYNOPSIS OF THE NEW ENGLAND SPECIES OF COLLETES.

BY W. H. PATTON.

I. Space between the eye and the mandible of twice the usual length. *C. valida* Cress.

II. Space between the eye and the mandible less than the width of the eye.

- A. Tarsal claws cleft in the ♀, venter densely pubescent; (♂ unknown). *C. aestivalis* sp. n.
- B. Tarsal claws of the ♀, with a sharp tooth beneath, venter not densely pubescent.
  - a. Labrum with a central rounded elevation, (most distinct in the ♀); ♂, space between eye and mandible unusually long; ♀, ventral valve carinated on each side. *C. compacta* Cress.
  - b. Labrum with a central pit.
    - 1. Prothorax with a prominent lateral spine. *C. armata* sp. n. (= *C. inaequalis* Cress., *nec* Say.)
    - 2. Angles of the prothorax not prominent.
      - Pubescence lemon-yellow, abdominal fasciae broad; wings short, tinged with white. *C. americana* Cress.
      - Pubescence griseous, abdominal fascia slender; wings of the usual length, hyaline. *C. scitula* sp. n.
  - c. Labrum with a distinct depression on each side and two less distinct depressions between; space between eye and mandible no longer in the ♂ than in the ♀; ventral valve of the ♀ not carinated. *C. inaequalis* Say. (= *C. propinqua* Cress.)

Colletes aestivalis sp. n.

♀. Length 11 mm. Black, the pubescence white, that on the inner face of the tarsi tinged with yellow. Tips of the mandibles and of the tarsi, rufo-piceous; the tarsal claws cleft, terminating in two equal teeth. Space between the eyes and mandibles moderate; clypeus confluently punctured, the punctures running into rugae towards the tip. Base of the labrum with a distinct median impressed line and on each side of this a shorter impressed line, and some slight impressions visible only in certain lights. Head and thorax punctured; a smooth spot on the disk of the mesothorax, a smooth impressed line on each side of the disk and a similar line extending anteriorly in the middle. Angles of the prothorax slightly produced; anterior coxae produced into a spine at the tip. Metathorax reticulated at the base, the sides punctured, the punctures coarser above. Abdomen convex, as wide at the base as in the middle, distinctly punctured. The four basal segments with a narrow continuous fascia of appressed white pubescence; the scattered pubescence on the first and second segments white, that on the other segments fuscous. The venter more pubescent than usual in Colletes, this pubescence tufted on the disk and retaining pollen as well as that upon the trochanters, femora and tibiae of the posterior legs. Wings hyaline, nervures testaceous.

Waterbury, Conn., July 12, on the flowers of *Heuchera Americana* L.

A less perfect specimen (Waterbury, June 30,) has no distinct sculpture on the labrum, and the abdomen, owing to a different degree of contraction, is less convex; there is also seen to be a triangular, highly polished pit on the posterior face of the metathorax, beneath which are two other pits and above which is a polished space.

The long spine on anterior coxae, the cleft tarsal claws and the hairy venter are characters in which this differs from all other species examined. In the ♀ of *armata* and *americana* the spine on the coxae is less developed, and in the ♀ of *compacta* and *inaequalis* and in the ♂ of all the species the coxae are merely angulated. In *C. ciliata* sp. n. the tarsal claws are not so evenly cleft, and in *inaequalis* Say the venter is not so pubescent: those being the species which most closely approach *aestivalis* in these characters.

Colletes armata sp. n.

♀. Syn. *C. inaequalis* Cress., Proc. Bost. Soc. Nat. Hist., XII, 166 (1868): *nec* Say.

♂. Length 9 mm. Black, the pubescence white, that on the thorax above ochraceous. Space between eye and mandible less than the width of the eye, base of the labrum with a central enclosed pit and two or three less distinct pits on each side of it; clypeus confluently punctured, at the apex polished and irregularly punctured; vertex densely punctured, opake. Prothoracic spine prominent; mesothorax deeply punctured, the disk shining and more sparsely punctured, anteriorly a faintly impressed median line free from punctures. Base of metathorax with a transverse series of regular reticulations, the posterior face coarsely and irregularly reticulated, polished. Calcaria testaceous, apical joints of tarsi rufo-piceous, the tips of the joints with golden pubescence. Abdomen polished, densely and finely punctured, first segment thinly pubescent, the remaining segments with a short scattered pubescence, and all the segments, except the last, with an even apical fascia of appressed pubescence, the ventral segments with the fasciae uninterrupted. Wings hyaline, the nervures dark piceous.

In Connecticut this species, together with *C. compacta* and *C. americana*, is common in the autumn. I have found *C. inaequalis* Say, abundant on the willow-blossoms in Massachusetts.

Colletes scitula sp. n.

♂. Length 7 to 8 mm. Black, head, thorax, legs and basal segment of the abdomen clothed with long white pubescence, that on vertex and on thorax above mixed with fuscous. Margins of the abdominal segments with narrow continuous fasciae of appressed white pubescence, the fine scattered pubescence on the second and following dorsal segments black; the pubescence on the venter white, the fasciae uninterrupted. Tips of the mandibles and of the tarsi piceous, the calcaria and the base of the claws whitish testaceous. Space between eye and mandible moderate, clypeus rugose or puncto-striate, base of the labrum with an oblong pit in the centre, and with two or four smaller pits on each side. Spines of the prothorax moderate. Head and thorax coarsely punctured, the punctures small and confluent on face, dilated on pleura, and scattered on the disk of the thorax. Posterior face of the metathorax closely reticulated, with a highly polished triangular depression in the middle; beneath the apex of the triangle at the insertion of the abdomen two other depressions, and at the base of the triangle above two or four irregular enclosures of larger size than those at the sides. Abdomen shining, finely punctured, the venter tinged with piceous and more sparsely punctured. The contrast between the white fasciae and the deep black abdomen gives the species a very neat appearance. Wings hyaline, nervures and tegulae piceous.

Bethlehem, N. H., July 26 and 31; Jefferson, N. H., Aug. 2 and 18.

The spines of the prothorax are larger and stouter than in *C. americana*, being in that species very small and slender.

NOTES ON NORTH AMERICAN DECAPODA. BY J. S. KINGSLEY.

The specimens upon which this paper is based are to be found in the Museum of the Peabody Academy of Science at Salem, Mass.

MAIOIDEA.

Family MAIIDAE. Sub-Family PISINAE.

Genus MICROPHRYS M. Edw., (MILNIA Stm.).

Microphrys error sp. n.

Microphrys depressa Streets and Kingsley, Bulletin Essex Institute, IX, 103 (1877). (*non Fisheria depressa* Lockington.)

A further examination of the specimen sent by Mr. Lockington as a type of his *Fisheria depressa* convinces me that it is not the species described by him under that name. I regard it as belonging to the genus Microphrys (Milnia Stm.) but it differs from Stimpson's diagnosis of the genus in the following respects. The orbits have a distinct fissure above, and no trace of a second; the basal joint of the antenna has one strong spine at the external angle, but no second smaller one. The external maxillipeds and dactyli of the ambulatory feet strongly resemble those of *M. bicornutus.* Should it be thought that these characters of antennae and orbits are of generic value, I would propose the generic name Eumilnia.

In the single specimen (a male) before me, I note the following characters.

Carapax depressed, regions very distinct and protuberant (more so than in *M. bicornutus*), hairy and armed with smaller and more acute tubercles than in that species. There are two strong spines on the posterior portion of the branchial region, near together and placed further back than the single one in *M. bicornutus.* A transverse crowded row of spiniform tubercles crosses the intestinal region. Margin of the hepatic region with an imbricated process, and on the branchial region an imbricated laminiform ridge, beneath the anterior portion of which is a strong styliform tooth. Rostrum with the horns straight, divergent, and not at all incurved at the tips. Orbits with a strong, prominent, acute tooth at the inner angle and a single distinct fissure above. Basal joint of antenna with a single spine at the external distal angle, which is longer and more acute than in *M. bicornutus.* Chelipeds moderate; meros with one or two teeth at the proximal portion above, distally with a laminiform crest; carpus externally tuberculate; hand compressed, fingers widely gaping, distally toothed, pollex bent downwards and then upwards, dactylus regularly curved, with a tooth on the occludent margin near the base.

Remaining feet slender, cylindrical, decreasing in length backward; meros and carpus of the first pair of ambulatory feet, each with a long, slender, acute spine above, near the distal extremities; propodal joints of all the feet with a rounded laminiform process for the articulation of the dactyli; dactyli strongly curved, pectino-denticulate beneath.

One male in the Museum of the Peabody Academy of Science from Lower California gives the following measurements.

Length of carapax, 17.5 mm.; breadth, 13.5 mm.; ratio, 1: 0.72.

This species differs from *M. aculeatus* as shown in Bell's description and figure (Trans. Zool. Soc., London, II, 50, pl. IX, f. 7.) in having many tubercles on the cardiac region, and only two spines on each branchial region (*M. aculeatus* has four), in wanting the spines on the meros of third pair of feet, and from both *M. aculeatus* and *M. bicornutus* in having the horns of the rostrum straight and not incurved.

Genus ANAPTYCHUS Stm. (ALA Lockington).

Anaptychus cornutus Stm.

Anaptychus cornutus Stimpson, Annals N. Y. Lyceum, VII, 184, pl. II, f. 1, (1859); Streets and Kingsley, *l. c.*, IX, 105, (1877). *Ala spinosa* Lockington, Proceedings of the California Academy of Science, VII, 66, (1877, extras issued in 1876).

In addition to the characters given by Stimpson, the following may be observed in the specimen sent by Mr. Lockington from the Gulf of California as the type of his *Ala spinosa*. The median portion of the posterior crest six lobed; there are nine depressed tubercles on the gastric region, and in our specimen the first tooth of the antero-lateral margin is narrower and more slender than it is represented in Stimpson's figure.

Length of carapax, 19 mm.; greatest breadth, 24 mm.; ratio, 1: 1.24.

Sub-Family MITHRACINAE.

Genus MITHRACULUS White.

Mithraculus areolatus Streets and Kingsley.

Mithrax areolatus Lockington, *l. c.* VII, 71, (1876). *Mithraculus areolatus* Streets and Kingsley, *l. c.* IX, 104, (1817).

Carapax naked, depressed, deeply areolate, areolations less broken than in *M. sculptus*, punctate, a transverse of five tubercles on the gastric region and two more acute ones on the outer posterior portion of each branchial region, two prominent tubercles at the base of the rostrum, one on each side of the median line. Rostrum short, bifid, outer margins of horns arcuate, inner straight. Orbits with one distinct fissure above, inner angle prominent, rounded; outer also rounded but less prominent; external hiatus a rounded opening. Antero-lateral margin with three teeth, besides the external angle of the orbit, first and second teeth stout, prominent, obtuse, the second the larger; third tooth slender, acute, hooked forward; a small acute tooth on the postero-lateral margin behind the lateral angle. A tubercle on the subhepatic region beneath the first tooth of the antero-lateral margin. An oblique row of rounded tubercles running backward from the palatal region. Basal joint of antenna with two short blunt teeth. Chelipeds small; posterior margin of meros four toothed, upper surface with one tooth, inner margin with a single rounded tubercle; carpus prominently tuberculate; hand smooth, inflated, cristate above at the base, a small depressed tubercle on the outer surface at the articulation with the carpus; fingers moderately gaping, denticulated at the extremity, a basal tooth on the dactylus in both sexes, but the larger in the male. Ambulatory feet with spinous tubercles on the basal joints, becoming obsolete on the distal ones; dactyli strongly arcuate. Specimens from the Gulf of California sent by Mr. Lockington have the following dimensions.

Length of carapax, ♂, 11 mm., ♀, 11.7 mm.; breadth, ♂, 13.5 mm., ♀, 15 mm.; ratio, ♂, 1: 1.23, ♀, 1: 1.28.

This species differs from *M. cinctimanus*, *denticulatus*, *hirsutipes* (sp.n.) and *minutus* (*Mithrax minutus* Saussure) in having but three teeth on the antero-lateral margin; from *M. denticulatus*, *ruber*, *hirsutipes* and *sculptus* in the presence of a basal tooth on the dactylus of the chelipeds; from *M. sculptus*, *cinctimanus* and *coronatus* in having the ridge running backward from the palatal region tuberculate; from *M. nodosus* in having the orbit fissured above, and in the more acute lateral tooth. It appears to be most closely allied to *M. ruber* but lacks the sinuous character of the anterior margin of the external maxillipeds, found in that species.

Mithraculus hirsutipes sp. n.

Carapax smooth, naked, sculptured, with four tubercles on the externo-posterior portion of each branchial region, and a single one at the base of each horn of the rostrum. Rostrum short, bilobed; orbits with a single fissure above, below with a deep groove externally and a fissure further in. Antero-lateral margin with four teeth, besides the external orbital angle, the first rather obtuse, the rest acute, second the largest, the last the most acute and strongly hooked forward; behind this last is a small tooth on the postero-lateral margin; a small tubercle on the subhepatic region a little in advance of the first antero-lateral tooth. The oblique ridge running backward from the palatal region is tuberculate. Basal joint of antenna with a short obtuse tooth, the two last joints of the peduncle with a stiff bristle on the inner distal angle. Chelipeds moderate, meros with spiniform tubercles above, inner margin with two spines near the distal extremity; carpus and hand smooth, the latter compressed, the fingers not so long as the palm, not denticulate, and with no tooth on the dactylus at the base. Remaining feet stout; meral, carpal and propodal joints armed with spiniform tubercles, and together with the basal portion of the dactyli, covered with long, stout hairs; distal portion of dactyli naked, strongly curved. Two specimens were brought from Key West, Fla., by Dr. A. S. Packard, Jr.

Length of carapax, 14 mm.; breadth, 17 mm.; ratio, 1: 1.21.

It differs from *M. nodosus*, *coronatus*, *areolatus*, *ruber* and *sculptus* in having the antero-lateral margin four-toothed; from *M. coronatus* in its narrower carapax and rounder outline; from *M. cinctimanus* in the broader carapax, the acute antero-lateral teeth and the absence of teeth on the fingers of the chelipeds; from *M. minutus* and *denticulatus* in the same character of the fingers.

Genus MITHRAX Leach, Stimpson.

Mithrax trispinosus sp. n.

Carapax depressed, pubescent, about as long as broad, surface granulate, with scattered tubercles. Of these there is one on each side of the median line near the base of the rostrum, three on each hepatic region, four on each branchial region near the base of the second tooth, and others posterior to these, a transverse row of four prominent ones, with smaller ones on each side, near the posterior margin. Rostrum short, depressed, bifid, each horn terminated by three spines. Orbits with two large fissures above, below with two broad, acute teeth. Antero-lateral margin with four sub-equal, slender, acute, curved teeth; a small one on the postero-lateral margin behind the lateral tooth. Sub-hepatic regions with spiniform tubercles. Basal joints of antennae with hairs and short setae. Chelipeds short and very slender, hand naked, the other joints and ambulatory feet above with spines and spiniform tubercles interspersed with short hairs. Dactyli of four posterior pairs curved, acute.

Florida. A. S. Packard, Jr.

A male gives the following measurements.

Length of carapax, 10 mm.; breadth, 10.5 mm.; ratio, 1:1.05.

This species differs from *M. affinis*, *acuticornis*, and *Holderi* in having the rostral horns spined instead of obtuse and unarmed; from *M. coronatus* in the broader carapax and non-acuminate horns; from *M. spinosissimus* in the simple character of the antero-lateral teeth; from *M. aculeatus* and *verrucosus* in having the basal joint of antennae two spined; from *M. hispidus* in the absence of sulci, and presence of granulations on the carapax, the more spiniform marginal teeth and longer rostral horns; from *M. pleuracanthus* in the granulate carapax and the character of rostrum, and from *M. verrucosus* in the rostral horns and the acute marginal teeth.

Mithrax triangulatus.

Mithraculus triangulatus Lockington, Proc. Cal. Acad., VII, 73, (1876).

Carapax with the regions very protuberant and tuberculate, especially the outer part of the branchial, the gastric and cardiac. Rostrum short, bifid, horns extending beyond the orbits, with the margins crenulate. Inner angle of orbits prominent, acute; superior margin with two nearly obsolete fissures, external hiatus moderate; below, a fissure at the junction of the basal joint of antennae. Antero-lateral margin three lobed, and below the lobes perpendicular. Below with two tubercles beneath the orbit, one small one on the subhepatic region and three rows of tubercles on the perpendicular surface of the branchial region, the lower of which extends obliquely forward to the angle of the palatal region. Basal joint of antennae very broad with two teeth, (not spines). Chelipeds moderate, meros sub-cylindrical with a few small tubercles; carpus nearly smooth, rounded; hand inflated, smooth, fingers moderately gaping, extremities denticulate, a strong basal tooth on the dactylus. Remaining feet small, spino-tuberculate.

Gulf of California. W. N. Lockington.

Length of carapax, ♂, 12.4 mm., ♀, 11.1 mm.; breadth, ♂, 11.5 mm., ♀, 11.0 mm.; ratio, ♂, 1 : .93, ♀, 1: .99.

Family PARTHENOPIDÆ. Sub-Family PARTHENOPINÆ.

Genus LAMBRUS Leach.

Lambrus granulatus sp. n.

Carapax broader than long, everywhere granulate and with scattered tubercles; of these there are four in the median line, three on the cardiac region and the fourth on the posterior margin; four distant ones on the branchial regions and an indistinct one on the hepatic region. Rostrum moderate, directed downward, the sides (inner borders of the orbits) elevated, extremity acute with a single tooth on each side at the base. Orbits with a distinct fissure above. Antero-lateral margin strongly angulated at about the middle, with about thirteen serrated teeth, of which seven are posterior to the angle; posterior tooth larger and stouter than the rest and directed slightly backwards. Posterior margin with three tubercles. Subhepatic and pterygostomian regions excavate as in *L. crenulatus* and *laciniatus*. Sternum granulate. Chelipeds long, surface everywhere granulate; meros nearly triangular in section, bordered with large serrated teeth on the two upper margins and with smaller ones beneath; a tuberculate crest on the upper surface; carpus with two large teeth on the outside and a number of smaller ones on the inner; upper surface of hand without tubercles, superior and inferior margins with fine teeth, outer margin with alternate large and small teeth; fingers strongly inflexed. Remaining feet slender, of moderate length. First segment of male abdomen with a transverse series of five tubercles.

Tortugas, Fla., (9 faths.). Lieut. Jacques.

Length of carapax, ♂, 8 mm.; breadth, 9 mm.; ratio, 1: 1.25.

This form differs from *L. Pourtalesii* in the ornamentation of the carapax, the absence of a hepatic tooth, in the large number of marginal teeth; from *L. agonus* in the angulated sides.

It is nearest *L. crenulatus* and would fall in the section which Dr. Stimpson has designated under the name Platylambrus.[1] It is, however, separated from this species by the more slender rostrum, the less prominenttooth at the lateral angle, the and smaller number of tubercles on the carapax; the regions also are not so well defined.

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[1] Bulletin Museum Comparative Zoology, II, 129, (1871).

CANCROIDEA.

Family CANCRIDÆ. Sub-Family XANTHINÆ.

Genus PANOPEUS Edwards.

Panopeus affinis Streets and Kingsley.

Panopeus transversus Lockington, Proc. Cal. Acad., VII, 102 (1876) *non* Stm. *Panopeus affinis* Streets and Kingsley, Bulletin Essex Inst., IX, 106 (1877).

Carapax depressed, slightly convex, and with the exception of frontal and antero-lateral portions which are granulate and sparsely pubescent, the surface is smooth and naked. Front rather prominent, bilobed, the lobes being truncate, not sinuate, the sides more advanced than the middle. The two fissures of the upper margin of the orbits more distinct than in *P. transversus*; the inner portion of the upper margin is elevated, forming a distinct angle with the upper surface of the frontal region. Antero-lateral margin with teeth rather than lobes, the first (the second normal tooth united to the angle of the orbit) is slightly sinuate as in *P. crenatus*, but is not so broad as in that species. Remaining teeth acute with their exterior margins arcuate, the margins of all the teeth slightly elevated. Under surface granulate, pubescent, subhepatic tubercle indistinct. Chelipeds unequal, carpus of each smooth, with a short spine on the inner margin; large hand smooth, the tooth on the outside of the palm obsolete; dactylus of larger hand with a strong basal tooth. Palm of smaller hand roughened above; fingers of both hands with longitudinal impressed lines, better defined, however, on the smaller. Remaining feet compressed, pubescent; dactyli of second, third and fourth pairs long and slender, of fifth pair much shorter. Terminal segment of male abdomen no broader than the preceding joint, sides slightly arcuate, tip rounded.

Lower California. W. N. Lockington.

Length of carapax, ♂, 10.8 mm., ♀, 12.7 mm.; breadth, ♂, 15.2 mm., ♀, 16.7 mm.; ratio, ♂, 1 : 1.41, ♀, 1 : 1.31.

It is closely related to *P. transversus* Stm., and *P. crenatus* Edw. and Lucas, but is distinguished from both by the truncate, non sinuate front and the less lobular teeth of the antero-lateral margin with their elevated borders. From *P. crenatus* it is also separated by the presence of a sub-hepatic tubercle and a more depressed carapax; from *P. transversus* by the more concave upper margin of the orbit, its elevated inner portion and the more acute carpal spine.

Panopeus purpureus Lockington.

Panopeus purpureus Lockington, *l. c.* VII, 101, 1876; Streets and Kingsley, *l. c.* IX, 105 (1877).

This form is very near *P. validus* Smith, and probably will prove to be merely a variety of it. In comparison with Smith's description and with authentic specimens of *P. validus* brought from the Gulf of Fonseca, by J. A. McNiel, it presents the following differences: Carapax smoother, and the granulous rugæ less numerous; front less prominent and, seen from above, nearly straight; fissures of the orbit less evident; tooth at inner angle of orbit below broader and shorter, second normal tooth of antero-lateral margin separated from the angle of the orbit by a narrower, more triangular notch; notches between the remaining teeth narrower, the teeth themselves having a distinct elevated margin. Propodus of chelipeds with an obtuse crest above; the tooth on the outer surface of larger hand nearly obsolete, dactylus with a large basal tooth. Ambulatory feet less compressed than in *P. validus.*

Lower California. W. N. Lockington.

Length of carapax, ♂, 11.1 mm.; breadth, 15.4 mm.; ratio, 1: 1.39.

Gulf of Fonseca, west coast of Nicaragua, J. A. McNiel.

Length of carapax, ♂, 13.2 mm.; breadth, 18.3 mm.; ratio, 1: 1.39.

Panopeus Packardii sp. n.

Carapax moderately convex; areolations less prominent than in *P. Herbstii*, surface minutely granulous. Front prominent, nearly horizontal; edge thin, arcuate, bilobed, the lobes being separated by a shallow groove. Orbits with two fissures above; post orbital tooth separated from the second tooth nearly as in *P. americanus* Saussure; the remaining teeth more acute than in *P. Herbstii.* External hiatus of orbit a narrow fissure. Sub-hepatic tubercle present, small; subhepatic regions minutely granulate. Chelipeds unequal; meros with one or two spines on the superior margin near the middle; carpus with a spine on the inner margin; larger hand stout, a rounded tooth below the articulation of the dactylus, dactylus with a strong basal tooth; fingers slightly deflexed; smaller hand with the tooth near the articulation of the dactylus broader and less prominent, and the fingers more strongly deflexed than in the larger hand, dactylus without a basal tooth.

Key West, Florida. A. S. Packard, Jr.

Length of carapax, ♂, 10.5 mm.; breadth, 14 mm.; ratio, 1: 1.33.

This species differs from *P. serratus*, *Hartii*, *americanus*, *politus* and *transversus* in the acute antero-lateral teeth; from *P. Herbstii*, *planissimus*, *abbreviatus* and *depressus* in the produced, arcuate, bilobed front; from *P. texanus* in the presence of a tooth on the external surface of the hand, and in having the terminal joint of the male abdomen triangular and no broader than preceding joint; from *P. occidentalis*, *Sayi* and *texanus* in the basal tooth of the dactylus; and from *P. Wurdemanni* and *Harrisii* in having the edge of the front simple, while in those species it is bi-marginate.

Panopeus sp.

? *Xanthodes leucomanus* Lockington, *l. c.* VII, 100 (1876).

The specimen sent by Mr. Lockington as the type of his *X. leucomanus* is a species of Panopeus very near *P. crenatus* Edw. and Lucas, but is too young for specific determination.

Genus XANTHO Leach.

Xantho novem-dentatus Lockington.

Xantho novem-dentatus Lockington, *l. c.* VII, 32 and 99 (1876).

Carapax moderately convex in front, the anterior portion roughened, behind smooth; the areolations in front are well marked and protuberant. Front produced as in the allied species (*X. 16-dentatus* and *vittata*) two lobed, lobes arcuate with crenulated margins and separated from each other by a slight fissure, and from the prominent inner angle of the orbit by a deep rounded notch. Orbits two fissured above. Antero-lateral margin with seven small, sharp, distant teeth; one or two small teeth on the postero-lateral margin behind the lateral angle. Chelipeds unequal, carpus and hand roughened above, the spine on the inner surface of the carpus small, acute; hands with a sulcated crest above. Posterior feet compressed, ciliated, not armed with spines.

Lower California. W. N. Lockington.

Length of carapax, 11.7 mm.; breadth, 15.2 mm.; ratio, 1: 1.30.

Is very closely allied to *X. 16–dentatus* Edw. and Lucas, *X. vittata* Stimpson, and falls in Lucas' genus Paraxanthus. It is separated from *X. 16–dentatus* by the more distinct areolation of the carapax, and the arcuate front; from Stimpson's description of *X. vittata* by not having the gastric region divided into three lobules, and by the crenulated non-ciliated front.

Genus CHLORODIUS Leach.

Chlorodius Fisheri Lockington.

Chlorodius Fisheri Lockington, *l. c.* VII, 104 (1876). Streets and Kingsley, *l. c.*, IX, 106 (1877).

This species belongs to the second section of the genus characterized by Prof. Dana, in the U. S. Exploring Expedition Crustacea, as having the carapax areolate in front, behind smooth or imperfectly areolate. Areolet "2 m" not subdivided. Anterior feet unarmed above. Third joint of the eight posterior feet not spinulose.

Carapax moderately areolate in front, obscurely so posteriorly, areolets not so prominent as in *C. floridanus* and *exaratus*; surface slightly rugulose anteriorly, but less so than in *C. floridanus.* Front two lobed, lobes separated by a narrow, acute fissure and with their anterior margins truncate, margins sulcate but not so deeply as in *C. floridanus.* Orbits two fissured above, entire below, the inner inferior angle acute. Antero-lateral margin four-toothed, teeth nearly as in *C. floridanus.* A small tubercle exists between and below the angle of the orbit and the first antero-lateral tooth. Carpus and hand of chelipeds slightly roughened exteriorly, but not so much so as in *C. floridanus.* Posterior feet compressed, unarmed.

Gulf of California. W. N. Lockington.

Length of carapax, ♂, 10 mm., ♀, 15.4 mm.; breadth, ♂, 14 mm., ♀, 22 mm.; ratio, ♂, 1 : 1.40, ♀, 1: 1.43.

This species differs from Stimpson's short description of *C. occidentalis* (Annals N. Y. Lyc., x, 108) in the narrower carapax, the length being to the breadth in the ratio 1 : 1.64, and in the form of the front. Stimpson says "the median lobes, or teeth of the front, do not project beyond the lateral ones." From *C. floridanus* it differs in the less protuberant areolets, the truncate frontal lobes, the smoother chelipeds, and the less concave sides of the terminal segment of the male abdomen.

Family ERIPHIDAE. Sub-Family OZINÆ.

Genus PILUMNUS Leach.

Pilumnus spinohirsutus Streets and Kingsley.

Acanthus spinohirsutus Lockington, *l. c.*, VII, 32 and 102 (1876). *Pilumnus spinohirsutus* Streets and Kingsley, *l. c.*, IX, 107 (1877).

Carapax arcuate, covered with scattered tubercles, which behind are squamiform and nearly obsolete, but in front are prominent and almost spiniform. Areolations but faintly marked. Front depressed with two prominent lobes separated by a fissure, and each lobe armed with a varying number (three to five) acute spines. The lobes are emarginate near the orbit, at the angle of which is a single stout spine. Orbits with distant spines above and below. Antero-lateral margin with three strong spines, and beneath and in front of the first of these is another. Pterygostomian region tuberculate. Meros of chelipeds with a spine, at the upper distal angle an emargination interior to this spine, behind which is a second spine; carpus and propodus with strong spines and hairs on the upper and outer surfaces, which below are arranged in rows and become tuberculiform; fingers dark brown, almost black. Ambulatory feet with long hairs on all the joints, and slender spines on the carpal, meral, and distal portion of the ischial joints.

Gulf of California. W. N. Lockington.

Length of carapax, ♂, 11 mm., ♀, 17.8 mm.; breadth, ♂, 16.7 mm., ♀, 24.8 mm.; ratio, ♂, 1: 1.52, ♀, 1: 1.41.

Pilumnus dasypodus sp. n.

Carapax transversely nearly flat, but longitudinally strongly arcuate, smooth behind but with the areolations moderately distinct anteriorly, clothed with long clavate hairs and stiff setae. Front depressed, prominent, two lobed, the lobes being separated by a deep narrow fissure, and each armed with minute teeth. Orbits with distant spines above and below, hiatus wanting. Antero-lateral margin with three strong simple spiniform teeth besides the one at the angle of the orbit. No spines on the hepatic or pterygostomian regions. Chelipeds unequal, carpus and propodus armed above with strong spines, stiff setae and long clavate hairs which on the smaller hand extend on the external surface where the spines become tuberculiform, and are arranged in distinct rows; fingers short, stout, denticulated. Ambulatory feet stout, compressed.

Key West, Florida. A. S. Packard, Jr.

Length of carapax, ♂, 5 mm., ♀, (with eggs) 6.2 mm.; breadth, ♂, 7.2 mm., ♀, 8.8 mm.; ratio, ♂, 1: 1.44, ♀, 1: 1.42.

This form is distinguished from *P. aculeatus* by the absence of spines on the hepatic region, from *P. Xantusii*, *gemmatus*, *reticulatus*, *ceratopus*, *marginatus*, *Agassizii*, *caribaeus*, *floridanus*, *granulimanus*, *lacteus* and *nudifrons* by having the orbits with spines above and below; from *P. depressus* in the simple character of the antero-lateral teeth, from *P. lunatus* by the ridge on the endostome. It is nearly related to *P. spinohirsutus* of the Pacific coast, but differs in the denticulated instead of spiny front, and the absence of granulations on the pterygostomian region, etc.

Pilumnus melanacanthus sp. n.

Carapax depressed, regions but faintly indicated, minutely granulated, with several small spines on the hepatic regions. Front broad, horizontal, almost bimarginate; on the upper margin a transverse row of spines directed forward, below which is a second margin of four dentated lobes, the median two being narrow, long, and truncate, the lateral ones broad and arcuate in outline, the teeth becoming larger near the orbits. Orbits above and below with minute acute spines. Antero-lateral margin with three strong, acute spines (besides the angle of the orbit) hooked forward, between which are a number of smaller ones. No spines on the pterygostomian region. Anterior margin of palatal region spined. Chelipeds stout, and armed above with stout black spines. Ambulatory feet without spines, stout, compressed and hairy above.

Key West, Florida. A. S. Packard, Jr.

Length of carapax, 7 mm.; breadth, 9 mm.; ratio, 1: 1.28.

Is most nearly allied to *P. depressus* of the west coast, from which it differs in the spines of the antero-lateral margin, the absence of a subhepatic tooth and the spiniform ornamentation of the chelipeds. From *P. aculeatus* it is distinguished by the greater number of hepatic spines, and the absence of the pterygostomian spine; from *P. spinohirsutus* by the depressed and narrower carapax, and having the hands armed above only; from *P. gemmatus, Xantusii, reticulatus, lunatus, ceratopus, marginatus* and *floridanus* in having the orbits toothed above and below and with no hiatus, except the one at the inner angle; from *P. Agassizii* in the depressed carapax, absence of areolation, etc.

Family PORTUNIDAE. Sub-Family LUPINÆ.

Genus CALLINECTES Stimpson.

Callinectes dubia sp. n.

Surface finely granulate, median lobes of front small and not projecting as far as the lateral ones. Orbits with two obsolete fissures above. Antero-lateral margin with nine teeth, including the lateral tooth of the carapax; anterior tooth truncate, posterior acute, lateral tooth nearly three times as long as preceding one. Eyes moderate. Antennae about one-third the length of the carapax, the two distal joints of the peduncle subequal. External maxillipeds fringed with hairs, the surface granulate. Ischium of chelipeds minutely granulate, with three spines on the inner margin, the third farther from the second than the second from the first, external margin distally emarginate, external distal angle with a short acute spine; carpus externally with several irregular raised lines, a small spine externally. Hand slender, nearly as long as the carapax, and ornamented with raised lines; of these there are two on the upper surface, three on the inner, the lower being less distinct than the other two, and on the outer surface are two more, the lower being more distinct on the thumb but fading out about the middle of the palm. Fingers about as long as the palm, slender, and somewhat curved downward. Second and third pairs of feet compressed, subequal, fourth pair also compressed, the extremity of the dactylus reaching to the propodo-dactylic articulation of the preceding pair. Fifth pair equalling the fourth in length, the dactylus being a half longer than broad. Sternum nearly as long as broad, transversely but slightly convex. Abdomen of male slender, the sutures mostly indistinct, last segment tapering, as long as broad, extremity rounded. Verges slender, their distal portion straight and reaching to the middle of the third segment of the sternum, or nearly to the extremity of the penultimate segment of the abdomen.

This species resembles *C. pleuriticus* Ordway, more closely than it does any other west coast form. It differs however in the following particulars. The external teeth of the front are more prominent, the antero-lateral teeth are more crowded together, the fissures between them being nearly closed, the male verges are larger and with the extremities straight, and the antero-lateral margin is but very slightly arcuate.

Several specimens from the Gulf of Fonseca, west coast of Nicaragua. A male gives the following measurements.

Length of carapax, 21.3 mm.; breadth, 45 mm.; ratio, 1 : 2.11.

I have found it very difficult to distinguish the species of this genus as the published descriptions are almost wholly comparative, and unless one has a large proportion of the species, determination is by no means an easy matter.

OCYPODOIDEA.

Family GRAPSIDÆ. Sub-Family GRAPSINÆ.

Genus PACHYGRAPSUS Randall, Stimpson.

Pachygrapsus transversus Gibbes.

Grapsus transversus Gibbes, Proc. Am. Assoc. Adv. Sci., III, 181 (1851). *Pachygrapsus transversus* Gibbes, *l. c.*, 182, Stimpson, Annals N. Y. Lyc., VII, 64 (1859); *ibid*, *l. c.*, X, 113 (1871); Smith, Report Peabody Acad. Science, III, 91 (1871). *Metopograpsus dubius* Saussure, Crustacés Antilles, Mexique et Etats Unis, p. 29, pl. II, f. 16 (1858). *Metopograpsus miniatus* Saussure, *l. c.*, p. 28, pl. II, f. 17, (1858).

Carapax smooth, shining, with crenulated transverse ridges, oblique on the branchial regions. Supra-frontal lobes prominent, but not so much as in specimens of *P. plicatus* from Tahiti. Front sinuate, making with the inner margin of the orbit a right angle, and viewed from in front, undulating. Orbits with the inferior margin making a sharp angle with the external tooth. A single acute tooth on the lateral margin, margin generally arcuate. The meros of the external maxillipeds is as broad as long, chelipeds unequal; meros crossed by crenulated ridges similar to those on the carapax, inner distal margin armed with from three to five acute teeth; carpus with the ridges less distinct, a prominent rounded tooth on the inner surface; hand minutely granulate, margins rounded; a ridge runs on the lower outer surface from near the base of the palm to the extremity of the pollex; fingers slightly gaping, smooth above and below, the occludent margins finely toothed. Posterior feet with the distal inferior angle with two to four teeth; meros of the first three pairs with a sharp ridge on the anterior and posterior margins; meral and propodal joints of all the ambulatory feet with long hairs; dactyli spinose, stout and with scattered long hairs.

In examining fifty-five specimens of Pachygrapsi brought from Key West, Florida, by Dr. Packard, I found forty-nine specimens which I referred without a doubt to *P. transversus*, four to *P. gracilis* and two doubtful ones which resemble Saussure's description and figure of *Metopograpsus miniatus*. These have the narrower front and slightly more arcuate lateral margins, but I can hardly consider them as distinct from *P. transversus*. In the above forty-nine specimens of *P. transversus* I found a variation in the arcuation of the lateral margin, and in the relative widths of front and carapax; there is also a variation in the ornamentation of the carapax; in some the cardiac region is smooth, in others crossed by elevated ridges. It would thus seem proper to unite these two forms, especially since Saussure says in the closing paragraph of his description of *Metopograpsus dubius*, "Je ne connais pas suffisamment bien les rapports de différence qui séparent les crustacés assez rares de se genre pour oser rien formuler de précis quant à cette espèce, qui je serais enclin à considérer comme le femelle du *M. miniatus*, sans l'extrême largeur de son front et la forme bien différente de sa carapace."

Pachygrapsus gracilis Stimpson.

Metopograpsus gracilis Saussure, *l. c.*, p. 27, pl. II, f. 15 (1858). *Pachygrapsus gracilis* Stimpson, Annals N. Y. Lyc., x, 113 (1871).

This species is readily separated from the preceding by the following characters. Cardiac region without transverse elevated lines, supra-frontal lobes nearly obsolete; front regularly arcuate, making an angle of about one hundred and twenty degrees with the inner margin of the orbit, and viewed from in front nearly horizontal; inferior margin of orbit not making an angle with the external orbital tooth; lateral margin nearly straight; meros of external maxilliped a half broader than long. The upper margin of the dactyli of the chelipeds and lower margins of the hand are denticulated; the carapax is narrower and more convex than in *P. transversus*. There appears also the following difference in alcoholic specimens. In *P. transversus* there are irregular patches of darker color on the carapax and hands, while in *P. gracilis* there are minute specks of black on the same portions.

LEUCOSOIDEA.

Family CALAPPIDÆ. Sub-Family CALAPPINÆ.

Genus CALAPPA Fabr.

Calappa convexa Saussure.

Calappa convexa Saussure, Revue et Magazin de Zoologie, v, pl. XIII, f. 3, (1853); Stimpson, Boston Journal Nat. Hist., VI, 470, (1857); *ibid*, Annals N. Y. Lyceum Nat. Hist., x, 114, 1871. *Calappa xantusiana* Stm., Ann. N. Y. Lyc., VII, 237, (1860).

A large male of this species from Panama (J. H. Sternberg) gives the following measurements.

Length of carapax, 55 mm.; breadth, 83 mm.; ratio, 1: 1.51.

Saussure's measurements are : length of carapax, 1 in. 7 lines; breadth, 2 in.; ratio, 1: 1.26.

Stimpson's measurements are: length of carapax, 1.15 in.; breadth, 1.46 in.; ratio, 1: 1.27.

Other than this variation in proportions, which may be due to age, the specimen agrees well with the descriptions and figures quoted above. The following additional characters may however be noted: External maxillipeds hirsute, the ischium toothed on the inner margin; chelipeds externally tuberculate, the tubercles growing smaller and exhibiting a tendency to arrange themselves in rows below; a strong spine arises from the inferior margin of the propodus near the base and extends horizontally outward and forward. The dactylus of the (in our specimen) right hand is compressed, with a crest of rounded teeth above, the first being larger than, and somewhat distant from, the rest; a strong curved tooth projects downward from the outer surface of the dactylus near the articulation with the propodus. The second and third joints of the abdomen are broader than the following ones, the second being tuberculate; the last joint is a third longer than broad.

On a Possible Origin of Petrosilicious Rocks.

By W. O. Crosby.

One of the most interesting, and, geologically at least, one of the most important, results of the deep sea investigations carried on during the last decade, particularly by the Challenger Expedition, is the discovery that over very extensive areas in the deeper parts of the ocean, two remarkably fine and uniform and yet very dissimilar kinds of sediment are slowly accumulating. Of these, the first discovered and the best known is the globigerina-ooze, which appears in the dredge as an impalpable and tenacious calcareous slime or mud, consisting essentially of the shells of Globigerina and other Foraminifera, though often perceptibly silicious from the presence of sponge spicules, radiolarian skeletons, and diatom frustules, and frequently containing the hard parts of higher animals. This material forms a white powder on drying, and it is now generally recognized as a modern chalk deposit; a slight degree of induration, and a segregation of the silica being all that is required to give it the aspect of the true chalk with flints; and in many parts of the ocean its deposition has probably been uninterrupted since Cretaceous time.

The globigerina-ooze extends from the ordinary shore deposits to a depth of 2000 or 2500 fathoms, where it shades off gradually into the other distinct abyssal deposit, commonly designated as "red clay," which is found at nearly all points where the depth exceeds 2500 fathoms. Although quite homogeneous to the naked eye, under the microscope this material is resolved into three distinct portions: first, and principally, an amorphous and impalpable red clay, which is essentially a hydrous silicate of aluminum colored with the red oxide of iron; secondly, inorganic particles, which are easily proved to be minute flakes of pumice and exceedingly small crystalline fragments of volcanic minerals, including quartz, feldspar, mica, augite, hornblende, olivine, magnetite and titanic iron; thirdly, organic particles, which are mainly the silicious remains of Radiolaria and Diatoms, with now and then a partially decomposed fragment of some calcareous shell, either foraminiferous or molluscan.

Over the entire area, estimated by Prof. Wyville Thomson at not less than ten millions of square miles, where this red clay is accumulating, and especially in the deep water of the Pacific, the dredge brings up large numbers of nodules of very irregular forms and varying in size from minute grains to masses weighing several pounds, and consisting chiefly of the iron and manganese per-oxides arranged in concentric layers in the matrix of clay, around a nucleus formed by a shark's tooth, or a piece of bone, or an otolith, or a piece of siliceous sponge, or more frequently a fragment of pumice. Prof. Wyville Thomson has shown that we have in these nodules, and in some of their nuclei, " ample evidence that this abyssal deposit is taking place with extreme slowness; for the nodules are evidently formed in the clay, and the formation of the larger ones and the segregation of the material must have required a very long time; while many of the sharks' teeth forming the nuclei of the nodules, and which are frequently brought up uncoated with foreign matter, belong to species which we have every reason to believe to be extinct. Some teeth of a species of Carcharodon are of enormous size, four inches across the base, and are scarcely distinguishable from the huge teeth found in the Tertiary beds. On this point Mr. John Murray, also of the Challenger scientific staff, says: " When there has been no reason to suppose that the trawl has sunk more than one or two inches in the clay, we have had in the bag over a hundred sharks' teeth and between thirty and forty ear-bones of cetaceans. While in the globigerina, radiolarian, and diatom oozes, we have found during the whole cruise only one or two sharks' teeth and perhaps one tympanic bone. In shore deposits they were even more rare. These facts taken with others that will at once suggest themselves, go to show, as might be expected, that the shore deposits accumulate faster than the organic oozes, and these last faster than the deep sea clay."

Concerning the origin of the clay deposit very diverse opinions have been held. Prof. Wyville Thomson justly considers that the uniform character of the deposit renders untenable the view that it is " the most minutely divided material, the ultimate sediment, produced by the disintegration of the land, by rivers and by the action of the sea on exposed coasts, and held in suspension and distributed by ocean currents." The water at those great depths has been found to contain rather more than the normal amount of carbon dioxide, although animal life is much less abundant on those parts of the sea-floor than over the ooze areas, diminishing rapidly beyond a depth of 2000 fathoms; and Prof. Wyville Thomson suggests that a large part of this water has been last at the surface, in the form of circumpolar fresh-water ice, and hence, though fully charged with carbon dioxide, it may be comparatively free from calcium carbonate, and therefore capable of dissolving considerable amounts of that salt. There is no dearth of Foraminifera, or of shell-bearing pelagic Mollusca (Pteropods), in the water over the red clay areas; but when the animals are dead their shells are entirely dissolved during the slow descent to the bottom, or soon after. It has been ascertained that when dissolved in weak acid these shells from the bottom leave a residue of about one per cent., possessing all the essential characters of the red clay. Putting these facts together, Prof. Wyville Thomson, in 1874, reached the conclusion that the red clay is essentially the insoluble residue, the ash, as it were, of calcareous organisms such as form the globigerina-ooze.

Dr. Wm. B. Carpenter, on the contrary, while admitting the decomposition of the organic remains by carbon dioxide, asserts the *a priori* improbability of their affording a true ash or residue of the quality and in the quantity required; and is hence led to question the adequacy of this explanation of the origin of the red clay. He considers the clay as a hydrous silicate of aluminum and iron analogous to glauconite, the chief constituent of greensand, the difference in color appearing " to depend upon the degree of oxidation of the iron"; shows that a precisely similar ochreous material sometimes forms interior casts of foraminifera shells; and concludes that the clay, instead of being a genuine constituent of the shells, is a *post mortem* deposit in their chambers.

The question, however, as to whether any large proportion of the clay actually forms pseudomorphs after the shells of Foraminifera is not germane to the present discussion, since it is now generally admitted that, no matter how occurring, the red clay has its *origin* chiefly in a source which was at first entirely overlooked; viz., the alteration of the pumice and other feldspathic volcanic products, which are universally present in this deposit, and even now, in a more or less decomposed state, constitute a large part of its bulk.

Within recent years geologists generally have become familiar with the extensive sub-aerial decay of silicate minerals under the combined influence of carbonic acid and water; and it is well known that the red clay of the soil of unglaciated regions where crystalline rocks abound is the chief insoluble product of this rather complex reaction. But the fact that substantially similar chemical and physical conditions must obtain in the abysses of the ocean is only now becoming recognized. The low average temperature of the bottom water is an unfavorable circumstance, it is true, but this is offset by the finer mechanical division of the material to be acted upon. The paucity of life in these abyssal regions is favorable to the peroxidation of the iron and manganese, and it is probably to this cause that the red color of the deposit is due. Mr. Murray shows that the iron and manganese oxides have the same origin as the clay itself, though probably coming mainly from the more basic volcanic minerals, as olivine and augite, which are never free from these oxides.

In his address to the Geographical section of the British Association, at its meeting in August last, Prof. Wyville Thomson concludes an account of the deep sea clay as follows:—

"So far as we can judge, after a most careful comparative examination, the deposit which is at present being formed at extreme depths in the ocean does not correspond, either in structure or in chemical composition, with any known geological formation ; and, moreover, we are inclined to believe, from a consideration of their structure and of their imbedded organic remains, that none of the older formations were laid down at nearly so great depths — that, in fact, none of these have anything of an abyssal character. These late researches tend to show that during past geological changes abyssal beds have never been exposed, and it seems highly probable that until comparatively recent geological periods such beds have not been formed."

This last statement of Prof. Wyville Thomson is based upon a belief in the view concerning the permanence of continents and ocean basins, first distinctly stated by Prof. James D. Dana, which asserts that the existing general inequalities of the earth's surface were outlined at a very early period in geological history, and have become sharper and more prominent with the lapse of time; or, in other words, that the greater conductivity and consequently more rapid cooling along certain radii of the primitive globe determined the position of the land masses, and that all subsequent geological changes, and especially the continued action of this primal cause, have only tended to emphasize the original contrast between continent and sea, broadening and elevating the former, and narrowing and deepening the latter. And hence in continuing, Prof. Thomson says; "If this view be correct," as he evidently believes, "it is quite possible that until comparatively recent times no part of the ocean was sufficiently deep for the formation of a characteristic abyssal deposit."

Without desiring to call in question here the validity of Prof. Dana's theory, I would observe in opposition to Prof. Wyville Thomson's conclusions based thereon — first, that since according to our present knowledge, carbonic acid is, after the diffusion of the volcanic débris, the one important and efficient agent concerned in the formation of the red clay, it is easy to conceive that, before the enormous amounts of this gas now represented by carbonaceous materials in the forms of coals, pyroschists, and bitumens, and the still greater volumes locked up in the limestones, dolomites and iron ores of the globe, were removed from the atmosphere and, of course, in the same proportion from the ocean, the modern deep sea conditions might have obtained in shallower water; and, secondly, that the abyssal deposits do not appear to be wholly unrepresented among the geological formations now exposed to our observation. As already stated, Dr. Carpenter has called attention to the evident analogy in modes of occurrence and composition between the red clay and greensand which is so abundant at several geological horizons. Potash is an essential constituent of glauconite, and I am not aware that analysis has shown that this alkali forms more than one or two per cent. of the clay. We find a possible source of it, however, in decaying algæ; marine no less than terrestial vegetation, including sensible amounts of potash as an essential ingredient: and Dr. Hunt has shown us how by the contact of these with aluminous deposits the alkaline silicates are regenerated,—glauconite being formed where the potash is deficient, and feldspar where it is abundant.

It frequently happens that the silicious organisms always present in the clay predominate to such an extent as to give character to the deposit, which then becomes a diatomaceous or radiolarian ooze; and it is difficult to understand why such a deposit is not fairly represented by the well-known diatomaceous, or so-called infusorial, earths of Tertiary age, or even by the hornstones and cherts of the older formations. The radiolarian ooze has been found in the deepest parts of the Pacific, and nowhere at a less depth than 2250 fathoms. But little stress, however, can be properly laid upon the occurrence of diatomaceous earth and greensand in the geological formations, since there is no reason to doubt that these rocks were formed for the most part at least in comparatively shallow water.

Among the crystalline rocks there are many kinds which, for aught that we can now determine, may very well have had a deep sea origin; but the subsequent development of crystalline characters has, in most cases, rendered it impracticable to trace their histories. In the important group of the petrosilicious rocks, however, I am inclined to consider that we have an exception to this statement; for these are at best but imperfectly crystalline, so that it may be said with much probability that they are texturally but little altered. In England and throughout Europe petrosilex and felsite, following the classification of Phillips, and including with the former species the quartz-porphyry or elvanite, are generally regarded as always purely and truly igneous rocks. On this side of the Atlantic, however, radically different views are gaining ground. Prof. Dana classes this group among the metamorphic rocks, and Dr. T. Sterry Hunt has long taught their sedimentary origin. Exotic petrosilex and felsite undoubtedly exist, as where a portion of a granite mass has cooled too rapidly for perfect crystallization and is neither vitreous nor crystalline in its texture, but something intermediate; or an originally stratified petrosilex may be softened and forced out of its original position. Of this we have the clearest possible evidence among the petrosilicious rocks of Eastern Massachusetts.

But the stratification of most of the petrosilex of this and many other regions is too plain to be questioned, especially when their more general or geognostic relations point unequivocally to the same conclusion, as in the vicinity of Boston, where the rocks of this group are clearly interstratified with stratified diorite, gneiss and quartzite.

Considering then that the petrosilicious rocks belong normally to the stratified or sedimentary group, I will proceed to compare them with the deep sea clay; first, in their textural relations, and afterwards chemically.

The texture of the clay has been already described; it is nearly always microscopic, and might frequently, probably, be properly characterized as of almost molecular fineness. Petrosilex and felsite are commonly described as exceedingly intimate mixtures of the constituent minerals, — usually quartz and orthoclase, though sometimes orthoclase alone, for petrosilex; and feldspar, usually a triclinic species, with little or no free silica but often some hornblendic material, for felsite. In some cases the individual mineral particles are separable under the microscope, while in others the rock remains perfectly compact with the highest powers. Among those believing in the sedimentary origin of these rocks, the question has been raised as to whether mechanical or chemical forces have played the chief part in their formation; *i. e.*, as to whether they are mechanically formed sediment or a chemical precipitate; and some authorities have been led, chiefly by their almost molecular fineness, to adopt the latter view. In the red clay, however, we have a compromise between the two theories, since it consists of material which, having nearly reached the limit of division by mechanical means, is further subdivided chemically.

The chief chemical distinction between the red clay and the rocks in question arises from the dearth of alkalies in the former; but, as in the case of glauconite, we may look to decaying vegetation as a probable source of this ingredient, though this is in part unnecessary, since it must usually occur that some of the pumice and other alkaline silicates escape entire decomposition and thus retain a portion of their alkalies. And then, again, we might, perhaps, safely agree with Prof. Wyville Thomson that, in consequence of the greater shallowness of the primeval ocean, or for some other cause, the existing abyssal conditions failed to obtain in early geological times to the extent of there being sufficient carbon dioxide in the sea to effect the solution of the calcareous organisms and yet not enough to decompose more than a small proportion of the comminuted volcanic débris, which we have every reason to believe was diffused far more profusely in ancient than in modern times.

Dr. Jacobsen, of Kiel, and Mr. J. Y. Buchanan, chemist of the Challenger Expedition, have shown that the greater part of the carbonic acid in sea water is not held in simple solution, but enters into combination with the sulphates of lime and magnesia, forming rather anomalous compounds which are decomposed only when the water is boiled nearly to dryness. The sulphate of lime is particularly efficient in thus locking up the free carbonic acid, and since we know that this salt was far more abundant in the older seas, it seems reasonable to conclude that it may have had an appreciable effect in preventing the greater volumes of carbonic acid in early days from decomposing the feldspathic sediments of the deep sea.

The free silica or quartz so generally present in the petrosilicious rocks would, according to the view here advocated, have two principal sources,— the decomposing silicate minerals, and the silicious organisms always occurring in the abyssal deposits.

These rocks, which are widely distributed over the globe and compose formations of great extent, are undoubtedly of marine origin. We can scarcely regard them as shore deposits, and therefore it seems natural and legitimate to conclude that they were formed in the deep sea; and I would submit that they are very fairly represented by the modern abyssal accumulations, especially if we take into account the enormous period of time which has elapsed since their formation and the probable changes in the physics and chemistry of the sea which it has wrought.

The petrosilicious rocks are often distinctly and beautifully banded. This structure usually results from the alternation of very thin and regular quartzose and feldspathic layers, and although doubtless originating in, and determined in direction by, the sedimentary process, I think it can be proved that it has been made much sharper and more definite by a subsequent partial segregation of the ingredients, especially the silica. In some cases these quartzose layers reach the condition of jasper, or even of vitreous crystalline quartz, and then their concretionary nature is very plain. In the vicinity of Boston the individual bands or layers of the petrosilex vary from an almost microscopic thinness to nearly an inch thick; and there is a gradual passage from banding of agate-like regularity and evenness, where single layers are continuous for yards, to that in which the quartzose layers are reduced to irregular lenticular sheets only a few times longer than thick, the perfect lamination changing to a distinct schistosity, and this to a structure where the layers become extremely irregular, ending abruptly or anastomosing and dividing in a systemless manner until the rock becomes a sort of quartzose reticulation having the meshes filled with feldspathic material. True globular concretions or nodules, mainly of silex, are also common in our petrosilicious rocks.

It is well known that petrosilex sometimes passes gradually into rocks which are wholly silicious, so that we are warranted in saying that some jaspers and quartzites have been formed under substantially the same conditions as the petrosilicious rocks; and in some cases the structure and general relations of the jaspers point to the same conclusion.

Now one of the most interesting rocks in the Marquette iron district, in the Upper Peninsula of Michigan, and the one most closely associated with the iron ore, is a brownish or reddish jasper; it sometimes becomes chloritic or micaceous, passing into chlorite schist, etc., but for the most part it is a distinct and beautiful stratified jasper. This Lake Superior jasper, like all the petrosilicious rocks so far as known, belongs to the Huronian formation, and may, apparently, be fairly taken to represent the petrosilex and felsite characterising many other Huronian areas, but apparently wanting here. Its association with the iron ore is usually very intimate; the two substances being interlaminated in such a manner as to give rise to a banded structure which matches in all important particulars the banding of the petrosilex of eastern Massachusetts and other regions, the hematite simply taking the place of the feldspar. The extreme irregularity of the banding in many cases makes it not only proper but necessary for us to conclude that, as in the case of the petrosilex, it is largely the result of a segregating process, the two constituents, hematite and jasper, having been originally more intimately mixed.

With very few exceptions this Marquette ore always contains some oxide of manganese, usually from one to two per cent., though the ore from one bed contains nearly seven per cent.

Here, then, so far as chemical composition is concerned, we have a formation almost identical with some of the silicious oozes of the deep sea; while the chief structural distinction consists in the different forms of the segregated masses of the iron and manganese oxides, lenticular layers taking the place of irregularly rounded nodules, certainly a distinction of no great importance.

The iron ores of the Iron Mountain district in Missouri are also Huronian; and here the associated rock is a true petrosilex. The mingling of rock and ore is less perfect than in the Marquette district, but the general plan of the structure is the same. The red petrosilex is distinctly stratified, and the hematite is interstratified with it in a way to show that they are cotemporaneous deposits; although the hematite has experienced considerable segregation subsequently to the deposition. Prof. Pumpelly, in his report on this district, repeatedly speaks of these as segregated masses, and some of his figures show this very clearly. These Iron Mountain ores are very often manganiferous, and in some cases the manganese oxide forms from twenty to eighty per cent. of the whole.

The resemblance in modes of occurrence and structural peculiarities of the Iron Mountain and Lake Superior iron ores leaves little room to doubt that they are essentially similar deposits; and when the structure of the Marquette jasper ore, especially, is compared with that of many petrosilicious rocks, it is difficult to avoid the conclusion that they have some community of origin. And then, too, the ordinary petrosilicious rocks are not entirely non-ferruginous, since they are often of a deep red or brown color, and, in eastern Massachusetts, at least, contain occasional strings and veins of hematite.

Without claiming to have proved a connection between the stratified petrosilicious rocks with the associated iron and manganese ores, and the deep sea clays, I consider that the foregoing comparisons show that there is no sufficient warrant for the statement that the modern abyssal accumulations are analogous to nothing now exposed to our observation among the older formations of the globe.

Classification and Description of the American Species of Characeæ. By B. D. Halsted.[1]

The object of this paper is to present the results of a systematic study of the American species of Characeæ. In some cases the material at hand was not either in quantity or quality what one would desire in order to arrive at the most satisfactory conclusions. And again, owing to the unobtrusive habits of these plants, doubtless some, and perhaps many, species have still escaped the eye of the botanist or collector.

The principal material for study has been the large collection of undetermined American specimens in the Gray Herbarium. Besides this, private collections were kindly loaned by Dr. W. G. Farlow, of Harvard College, Professor Eaton, of Yale College, Professor C. E. Bessey, of Ames, Iowa, Dr. J. W. Robbins, of Uxbridge, Mass., Mr. John Robinson, of Salem, Mass., Mr. Chas. C. Frost, of Brattleboro, Vt., and others, to whom my thanks are due.

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[1] The present article forms a part of the thesis presented by the writer as a candidate for the degree of Doctor of Science of Harvard University in May, 1878.

By means of the Braun, Rabenhorst and Stitzenberger Characeæ Exsiccatae in Dr. W. G. Farlow's private collection, Nordstedt and Wohlstedt's Scandinavian Characeæ, and the general foreign collection in the Gray Herbarium, the American specimens have been compared directly with those of other countries.

The members of this distinct group of Cryptogams are all filamentous, submerged, aquatic plants, to the naked eye either green or ashy gray in color, depending upon the presence or absence of a calcareous incrustation. The plants are attached by a long, colorless, root-like structure to the muddy bottom of the pond or stream in which they grow, and often form dense masses varying according to the species from a few inches to two or three feet in height. They are remarkable for their large thin-walled cells and the cyclosis of their contents.

In number there is something over a hundred species.

Development: — At the upper end of the spore there is first produced by division a thin-walled, hemispherical shaped cell. This cell soon divides into two by a cell-wall parallel to the longer axis of the spore. Both of these new cells increase in size and push themselves out between the separating ends of the fine enveloping spirals, one turning downward to become the primary rhizoid, the other upward to form the proembryo. The proembryo, the upper portion of which is green, consists of but a few alternating nodal and internodal cells. When the Chara plant develops, one of the disc-shaped nodal cells divides up first into two, and afterwards, by successive divisions, into a number of cells, the largest one of which becomes the initial cell, or *punctum vegetationis* of the future plant. From this cell by further growth and repeated cell division the Chara plant is developed.

Antheridia (globules): — These, the male organs, are situated on the leaves and are often of an orange color, and from .50 to .75 mm. in diameter. The wall consists of eight cells called shields, closely joined by their serrate edges. The four basal ones are somewhat four sided; the upper four triangular. From the centre of each shield-cell there projects into the interior of the antheridium an oblong cell called the manubrium. Each manubrium is surmounted by a smaller cell known as a capitulum. The capitula end in turn in six secondary capitula from each of which grow four long flagelliform threads which are composed of small disc-shaped cells. The antherozoids are borne singly in the cells. When free from the cell the antherozoid is a spirally twisted, naked, protoplasmic body, many times longer than broad, and is capable of a very rapid motion by means of two cilia which are placed near one end.

Sporangia (*nucules*):—These are the female organs and when mature are usually of an ovoid shape, and .30 to 1.10 mm. in length. The sporangium consists of a large central cell, the spore, and five tubes which are coiled closely around it. The sporangium is a transformed leaflet.

Non-sexual organs of reproduction:—Bulblets are found in a number of species; they occur most frequently at the lower nodes of the plant near the surface of the ground, where few or no leaves are developed and the internodes are colorless.

A second method of non-sexual reproduction is found in *Chara fragilis*, which is called by Pringsheim[1] "Branches with naked base."

Classification:—It is difficult to place the Characeæ very close to any other group of Cryptogams. Their method of development, sexual organs, and anatomical structure separate them from the Vascular Cryptogams on the one side, and the Thallophytes on the other; and bring them nearer to the Muscineæ than to any other general group. Of the Muscineæ they bear the most resemblance to mosses. Differing as they do so widely, even from the mosses, in being less complex in structure and in the development of the fruit, it seems fitting that the Characeæ be placed in a group by themselves and arranged with the others in the following order, proceeding from the highest to the lowest: *Vascular Cryptogams*, *Muscineæ*, *Characeæ*, and *Thallophytes*.

Order CHARACEÆ.

Characters:—Aquatic, cryptogamic plants growing in tufts or masses on the bottoms of ponds or running streams, and attached to the muddy substratum by long, slender rhizoids. The plants are often of a bright green color, especially when young; but afterwards many species become incrusted with a coating of carbonate of lime and then present an ashy appearance and are fragile in structure.

The stems consist of single, long, cylindrical cells placed end to end; or with the addition of an enveloping coat of smaller parallel cells (cortication), the latter frequently provided with spines or papillæ.

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[1] Ueber die Vorkeime und die nacktfussigen Zweige der Charen. Pringhs., Jahrbücher. 3. p. 294.

At the joints, whorls of leaves are produced which may or may not be corticated. The leaves may be either simple, when they have a distinct main axis, and bear the sexual organs along the upper side (Chara), or compound, when they divide up into several parts, and bear the sexual organs in the forkings thus produced. (Nitella). At the node, in the axil of the oldest leaf (Chara) or the two oldest leaves (Nitella), a lateral branch arises, which repeats in all respects the structure of the primary stem.

The sexual organs consist of the male body antheridium, (globule), and female organ, sporangium, (nucule); both of which may be borne on the same plant (monœcious) or on different plants (diœcious).

The spore produces a proembryo in germination.

Nonsexual reproduction is by means of bulblets; branches with naked base, and proembryo-branches.

1. Family NITELLEÆ.

Plants monœcious or diœcious, *without cortications* and *stipular ring.* Leaves 5–8 in a whorl, with *leaflets* large and often *many celled.* Sporangia one to several, on a short basal cell, *in the forkings of the leaflets; crown* consisting of *two superimposed whorls* of five cells each. Covering of spore without calcareous incrustation.

1. Genus Nitella. Ag. em. A. Br.

Plants monœcious or diœcious. Primary leaflets all arise from the same node and are frequently repeatedly divided. *Antheridia terminal,* the basal cell *small. Sporangia beneath* the *antheridia,* single or in clusters.

Synopsis of the Species of Nitella.

Genus Nitella Ag. em. A. Br. Antheridia terminal.

A. *Ultimate divisions of leaves one celled.*	
1. *Diœcious.*	
a. Fruit in loose clusters.	*N. opaca* Ag.
b. Fruit in large dense heads.	*N. capitata* Nees.
2. *Monœcious.*	
a. Fruit in gelatinous heads.	*N. gelatinosa* A. Br.
b. Fruit not in gelatinous heads.	
α. Sporangia beaked.	*N. flexilis* Ag.
β. Sporangia not beaked.	*N. translucens* Ag

B. Ultimate divisions of leaves two celled.
  1. Whorls loosely branched. *N. gracilis* (Sm.) Ag.
  2. Whorls compact. *N. tenuissima* Kütz.
C. Ultimate divisions of leaves three celled.
  1. Whorls very large and spreading. *N. intricata* Roth.

Nitella opaca Ag.

Nitella opaca Ag. Agardh, Syst. Alg., 24; Wallman, Char., 31; A. Braun, in Krypt. Fl. Schlesien, 397. *Nitella syncarpa* var. *glomerata* A. Braun, Schweiz. Char., 7; Kütz., Sp. Alg., 614. *Nitella syncarpa* var. *Smithii* Coss. and Germ., Fl. Env. Par., 662. *Chara syncarpa* var. *opaca* A. Braun, in Flora, 1835, I, 52; Kütz., Phyc. Germ., 256.

Exsiccatae: Braun, Rabenhorst and Stizenberger, Char. Exsic., 29, 51, 52 and 53.

Illustration: Coss. and Germ., Atlas, Tab. 39.

Plants *diœcious*, medium size, *transparent*; whorls small, remote, approximating at the extremities of the stem, primary ones usually sterile; leaves twice or thrice branched, *ultimate divisions single-celled, apex obtuse.* Antheridia .50–.65 mm. in diameter, numerous, single, on small leaves; without gelatinous covering. Sporangia ovoid .7–1.0 mm. long; 5–6-striate, on short leaves which form *loose heads*: crown often deciduous.

This species, so abundantly represented in the Braun, Raben. and Stiz. Exsic. is with us comparatively rare. It has been found only in the far west: North-western Nevada, (Bailey).

In size, flexibility and color it much resembles *Chara coronata* var. *Schweinitzii*; but is readily distinguished from it, as well as from most of the American members of its own genus, by its diœcious character.

Nitella capitata Ag.

Nitella capitata Agardh, Syst. Alg., 125; Wallman, Char., 37; A. Braun in Krypt. Fl. Schles., 396. *Nitella syncarpa* var. *oxygyra* A. Braun, Schweiz. Char., 7. *Nitella syncarpa* var. *capitata* and *gleocarpa* Kütz., Phycol. germ., 256; Sp. Alg., 514.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 26, 27 and 28.

Illustration: Meyen in Linnaea, II, Tab. 3.

Plants *dioecious*, *large*, much branched, dark brown when dried; *whorls remote*, consisting of few and *long undivided leaves.* Sexual organs with *gelatinous covering.* Antheridia numerous, at apex of short leaves, forming clusters. Sporangia small, 6–8-striate, nearly spherical, on very short leaves which *form* a *dense head* at the base of the long sterile leaves; *crown* very *small* and *pointed*; spiral *bands prominent*; spore dark, reddish brown.

This attractive species is easily distinguished by its diœcious character and fertile heads. The only American specimens which we have seen were collected by Dr. Robbins in a canal at Uxbridge, Mass. It is mentioned by Mr. Allen[1] as being found in "small streams on Long Island." It is evidently one of our rarer species; though throughout Europe it is wide spread and comparatively common. No. 26 of Braun, Raben. and Stiz. Exsic., excepting its immaturity, agrees in all respects with our male specimens. Among foreign specimens, the female plants are subject to considerable variation while the male form is quite constant. Nordstedt and Wahlstedt's "*forma longifolia*" most nearly agrees with ours, but it does not have the fertile heads of more than half the size of the Uxbridge plants.

The male plants of this species are to be distinguished from those of the preceding, by their clusters of antheridia being surrounded by mucus.

Nitella gelatinosa var. **gigantea.**

Plants monœcious, *very large*, slightly branched; *stem* 2.–2.5 mm. *broad*; *whorls* of two kinds: *sterile* and *fertile*, the former consisting of 5–6 *simple, broad cells* 5–6 cm. long, 2–2.2 mm. broad, ending in obtuse tips; the *fertile whorls contracted into a dense spike and encased in a thick mass of jelly*; fertile spikes 1.5–2.5 cm. long, 1–1.2 cm. broad. Antheridia *surrounded* by an *involucre* of short bracts. Sporangia .65–.80 mm. long, 7–10-striate, spiral cells thick walled, *crown deciduous.*

In this variety we have the largest American representative of the genus. It differs from the typical form, *Nitella gelatinosa* A. Braun "*Charae Preissianae*" in Linnaea, 1843, p. 115, and "*Charae Australes* and *C. Antarcticae*" in Hook. Jour. Bot., p. 198, in being more than double the size of the latter. Kützing figures a number of varieties of *N. gelatinosa* in his Tabulae Phycologicae; and his var. *N. podostachya*, which is the most like our plant, is about one-fourth its size. Our plants are monœcious; his is figured as diœcious. No representatives of *N. gelatinosa* are given in either Braun, Raben. and Stiz. Exsic., or Nordstedt and Wahlstedt's Scand. Characeæ.

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[1] "Notes on Characeæ." T. F. Allen in Torrey Bulletin, II, 3 (1871).

The specimens upon which the variety is founded were collected by H. W. Ravenel previous to 1852. In a letter of that year they were sent to Dr. Gray, in which he says: "The Chara which grows submerged in the water of Santee Canal is unlike any American species I am acquainted with. The racemes are encased throughout their fructification in a gelatinous ball."

Nitella flexilis Ag.

Nitella flexilis Agardh, Syst. Alg., 124; Kütz., Phyc. Germ., 256; Sp. Alg., 514; A. Braun, in Krypt. Fl., Schlesien, 397. *Nitella Brongniartiana* Coss. and Germ., Fl. Env. Par., 682. *Chara flexilis* A. Braun in Flora 1835, I, 50; Babington, Man. Eng. Bot., 419.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 22 and 23.

Illustrations: Reichenb. Iconog., VIII, Tab. 785–796; Engl., Bot., XV, Tab., 1080; Coss. and Germ., Atlas, Tab. 40, C; Kütz., Tabulae Phycol., Vol. VIII, Tab. 32, 2.

Plants monœcious, *elongated*, slightly branched, bright green; *whorls remote*, consisting of *5–6 leaves*; leaves long twice to thrice divided, apex obtuse. Antheridia *large*, .50–.70 mm. in diameter, often congregated. Sporangia subglobose, *beaked*, .70–.85 mm. long, 7–8-striate.

This is one of the finest and most common species of the genus; and is well adapted for the study of the family. No specimens were found in the Gray Collection; but as it is common in the region of Cambridge no inconvenience from lack of material has been experienced.

Of the five specimens given in Nordstedt and Wahlstedt's collection their var. *N. crassa* most nearly resembles ours. No. 22 of Braun, Raben. and Stiz. Exsic., which they call the normal form, is the same as the American plants.

Reichenbach's Tab. 796, represents "*Chara flexilis* var. *nidifica*." This is one of the varieties of *N. flexilis* which has also received the names *Chara glomerulifolia* A. Br. and *N. flexilis* var. *subcapitata* A. Br. and is a contracted and very fertile form. No. 23 of Braun, Raben. and Stiz. Exsic. is of this last form, to which some of the Essex County specimens approach. Both the fertile, normal form and the larger sterile plants of the same, have been collected in abundance by Dr. Robbins in Uxbridge, Mass.; Brattleboro, Vt., (Frost); Merrimac, (Green).

Nitella translucens Ag.

Nitella translucens Agardh, Syst., Alg., 134; Kütz., Sp. Alg., 513; Wallman, Char., 27; Coss. and Germ., Fl., Env. Par., 683. *Chara* *translucens* A. Braun, in Flora, 1835, I, 50; Babington, Man. Eng. Bot., 420.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 19.

Illustrations: Engl. Bot., XXVI, Tab. 1855; Reichenb. Iconog., IX, Tab. 804–805; Coss. and Germ., Atlas, Tab. 40, B; Kütz., Tabulae Phycol., VIII, Tab. 26, 1.

Plants monœcious, *large*, *bright shining green*; sterile *whorls large*, composed of numerous, broad, *single-celled leaves*; fertile whorls small and near the tips of the branches. Antheridia situated near the apex of the leaves. Sporangia small, ovoid, aggregated, *5–7-striate*; *crown small*, .05–.07 mm. broad.

This is one of the largest and most showy of the Nitellae. When dried its shiny green color is in contrast with the dull appearance of most of the other species. Nordstedt and Wahlstedt's single specimen is of the elongated form, as is also the one in Braun, Raben. and Stiz. Exsiccatae.

In Herb. Gray are specimens marked " Flora Texana, F. Lindheimer, Seg. (461). — 4–6 feet long on bottom of deep clear ponds in deep shady woods near Guadaloupe, Aug. 1847." These plants are sterile. Specimens from western Texas (C. Wright, No. 1) are the same in all respects. Some of Bolander's Californian specimens bear fruit sparingly at the ends of the branches, while others fruit in all the numerous branches. Specimens from the San Francisco water-works are like the last though not so fertile. Specimens from Brattleboro, Vt. (Frost), are the only ones seen from the Eastern States. It is probably not so common here as through the South and West.

Nitella gracilis (Sm.) Ag.

Nitella gracilis (Sm.) Agardh, Syst. Alg., 125; Kütz., Sp. Alg., 515; Wallman, Char., 17; A. Braun, Schweiz. Char., 10; Coss. and Germ., Fl. Env. Par., 683; A. Braun, in Krypt. Fl. Schlesien, 399. *Chara gracilis*, Smith, Engl. Bot., Tab. 2140; A. Braun in Flora, 1835, 102.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 24, 25, 57 and 58.

Illustrations: Engl. Bot. Tab., 2140; Reichenb. Iconog., VIII, Tab., 782; Coss. and Germ., Atlas Tab., 40, E. 1 and 2; Kütz., Tabulae Phycol., VII, Tab. 34, I.

Plants monœcious, *slender*, *bright green*; whorls loose; leaves repeatedly 3–4 times divided, *ultimate divisions two to three*; ultimate segments long, apical cell conical, mucronate. Sporangia *globose*, *4–5 striate*, bands indistinct; *crown* often *deciduous*.

Form α. Plants *large,* diffusely branched, sterile whorls consisting of few loosely branched leaves; fertile ones small and near the tips of the branches.

Form β. Plants *small,* delicate, slightly branched, somewhat moniliform; whorls all fertile and dense.

This species is subject to considerable variation, often approximating to the next, *N. tenuissima,* though usually distinguished from it by a looser habit and brighter green color.

No. 27 of Braun, Raben. and Stiz. Exsic. is form β, which they call "Characteristische normalform." No. 59, "forma simplicior," is the normal form with smaller whorls. Some specimens from Dr. Robbins were like 59, while other plants from Uxbridge, Mass., were of an attenuated type and the finest specimens we have seen.

The ten specimens in Nordstedt and Wahlstedt's collection exhibit all gradations between the two forms figured in the plates. They make no varieties; but give five forms, their "forma laxior" being our form α.

Kützing's figure is of α and he gives no varieties in his Species Algarum. Reichenbach, Coss. and Germ., and the plate in the English Botany all agree with Kützing.

In Herb. Gray are plants from New Mexico (C. Wright, No. 24.) It has also been collected at Brattleboro, Vt., (Frost); Essex Co. (Robinson); Uxbridge, Mass., and Harwich, Mass., (Dr. Robbins).

The diffusely branched form grows at Nobska Pond near Wood's Holl, Mass. (Dr. Farlow), and Uxbridge, Mass. (Dr. Robbins).

Nitella tenuissima (Desv.) Kütz.

Nitella tenuissima Kütz. Phycol. germ., 256; Coss. and Germ., Fl. Env. Par., 683; Kütz. Sp. Alg., 515; A. Braun, Schweiz. Char., 10; in Krypt. Fl. Schlesien, 399. *Chara tenuissima* Desv., Babington, Man. Bot., 433.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 60.

Illustrations: Reichenb., Iconog. Tab. 791–792, Figs. 4065–67; Coss. and Germ., Atlas, Tab. 41, F. 1 and 2; Kütz., Tabulae Phycol., VII, Tab. 34, 8, 2.

Plants monœcious, *small, slightly branched, moniliform,* pale green; *whorls compact,* consisting of 6–8 leaves forming a *globose cluster* 2.5–3.5 mm. broad; leaves repeatedly divided, the lower divisions 5–7, upper usually three, *last segment longest,* ending with a small conical cell. Sporangia small subglobose 1.5–2.5 mm. long; 6–8-striate, crown short.

This is the smallest American species which we have seen. *N. batrachosperma*, a somewhat smaller species according to Mr. Allen,[1] has been found in this country.

The single specimen of Braun, Raben. and Stiz. Exsic, as also the one in Nordstedt and Wahlstedt's collection are identical with our own, and, as far as we know, the species is a very constant one. The only striking variation from the type is in Reichenbach's illustrations in which 791 represents the normal form and 792 "var. major" This latter corresponds so nearly to specimens and figures of *N. batrachosperma* that it may be that species.

Specimens in Herb. Gray are from Michigan (Dr. Cooley); Rhode Island (Dr. Robbins). Mr. Allen states that this species has been found at Peekskill, New York. The small size and obscure habit of the plant may account in a measure for the limited number of known localities.

Nitella (Tolypella) intricata (Roth.) Ag.

Nitella (*Tolypella*) *intricata* (Roth.) Agardh, Syst. Alg., 122; A. Braun, in Krypt. Fl. Schlesien, 400. *Nitella fasiculata* A. Braun, Schweiz. Char., 11; Kütz., Sp. Alg., 517. *Nitella polysperma* A. Br.; Kütz., Phyc. Germ., 255; Wallman, Char., 34. *Chara intricata* Roth. Catal., II, 125. *Chara polysperma* A. Braun, in Flora, 1835, I, 56.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 8 and 33.

Illustration: Kütz., Tabulae Phycol., VII, Tab. 36.

Plants monœcious, *large*; *whorls* numerous, *very large*, consisting of 8–10 leaves; leaves repeatedly twice to thrice divided, *flabellate*, dull green, *apex two-celled*, *mucronate*. Sporangia oval, somewhat beaked, .40–.55 mm. long, 7–8 striate, on short contracted whorls near the tips of the branches.

This species is one which is quite readily distinguished by its large wide spreading whorls of much branched dull green leaves.

Since *Tolypella* was established as a genus, this species has been generally called *Tolypella intricata* A. Br. Our specimens agree with those of Braun, Raben. and Stiz., Exsic. and Nordstedt and Wahlstedt; but we find the antheridia to be terminal. This fact is perfectly evident when the organs are examined in the young state. Usually a number of sporangia are produced at a forking, and as they increase in size, the antheridum, as it becomes old, is pushed out and made to assume a somewhat lateral position.

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[1] Torrey Bulletin, II, 3 (1871).

The species is a rather constant one, though some slight variations are noticeable. In Herb. Gray the specimens from Lousiana had but few leaves in the scattered whorls; those collected by Prof. E. Tuckerman in the White Mountains are diminutive, as also are those from Utah. The Tewksbury, Mass., specimens resemble those gathered by Mr. Wright in Leom River, Texas, being in size between the small specimens just mentioned and the large and showy plants of Boxford, Mass., (Robinson). A loose form of the species is found in Wading River, (Dr. Robbins). The same gentleman has collected the normal form at Uxbridge and Northbridge, Mass.

2. Genus TOLYPELLA A. Br.

Plants monœcious; leaves with 2–3 nodes bearing primary leaflets. Antheridia *lateral*, often with *long basal cell.* Sporangia in clusters.

Tolypella nidifica (Ag.) A. Br.

Tolypella nidifica A. Braun, in Krypt. Fl. Schlesien, 366. *Nitella nidifica* Agardh, Syst. Alg., 125; Kütz., Phyc. gen., 318; Phyc. germ., 255; Sp. Alg., 517. *Chara nidifica* Roth., Catal., II, 26.

Exsiccatae : Braun, Raben. and Stiz. Char. Exsic., 32 and 61.

Illustrations: Kütz., Tabulae Phycol., VII, Tab. 37; Fl. Dan. V., Tab. 741; Engl. Bot., XXIV, Tab. 1703.

Plants monœcious, much branched; *whorls compound*, remote; *secondary whorls dense* and fertile, *forming heads* composed of short scythe-shaped leaflets. Antheridia *lateral* and frequently *long stalked.* Sporangia nearly spherical, small, .38–.45 mm. long, 6–7-striate.

The Gray collection furnishes only one specimen of this species, it having been collected at San Rafael, California. The Braun, Raben. and Stiz. plants are of the normal form with which ours corresponds.

This is the only American member of the small genus *Tolypella.* The long stalks upon which some of the antheridia are borne are noticeable, and seem necessary where there are so many of these at the same joint.

2. Family CHAREAE.

Plants monœcious or diœcious; stems and leaves *with* or *without cortications*; whorls consisting of from 6–12 leaves; *stipular ring* at base of whorl; *bracts* of leaves (leaflets) *one-celled.* Antheridia and Sporangia on the *upper side* of the *leaves*; *crown of one whorl of five cells.* Spore with a coating of carbonate of lime.

3. Genus LYCHNOTHAMNUS Rupr.

Stipular ring simple; bracts only on upper side of leaves. Antheridia *by the side of the* Sporangia.

No members of this small genus have been found in the United States.

4. Genus CHARA Vaill. em. A. Br.

Stipular ring often double, bracts usually on all sides of the leaves. Antheridia *below the* Sporangia.

SYNOPSIS OF THE SPECIES OF CHARA.

- I. *Without cortication.*
  - *a.* Plants very large. *C. coronata* Ziz.
- II. *With cortications.*
  - A. *Diœcious.*
    - 1. Leaves entirely corticated. *C. crinita* Wallr.
    - 2. Leaves not entirely corticated.
      - a. Plants very large; diplostichous.[1] *C. ceratophylla* Wallr.
      - b. Plants rather small; triplostichous. *C. aspera* Willd.
  - B. *Monœcious.*
    - 1. Leaves having a naked basal internode.
      - a. Naked internode one-third length of leaf. *C. Robbinsii* n. sp.
      - b. Naked foot very short. *C. gymnopus* A. Br.
    - 2. Leaves having no naked basal internode.
      - a. Corticating cells diplostichous.
        - *α.* Spines between the furrows of the stem. *C. fœtida* A. Br
        - *β.* Spines not between the furrows of the stem. *C. contraria* A. Br.
      - b. Corticating cells triplostichous. *C. fragilis* Desv.

Chara coronata Ziz.

Chara coronata Ziz. A. Braun, in Flora, 1835, I, 95; Char. Afrik., 825; Kütz., Sp. Alg., 520; A. Braun, in Krypt. Fl. Schlesien, 403.

Illustration: Kütz., Tabulae Phycol., VII, Tab. 69, I.

Plants monœcious, *without cortication*, *one* to *three* feet long; stems .50–.75 mm broad, bright green, *without incrustation*, stipular ring *simple*; leaves with 6–10 articulations ending in a *crown* of 3–5

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[1] Diplostichous — signifying that the rows of corticating cells are twice as many as the leaves in the whorl next above. Triplostichous, when the rows are three times as many.

mucronate cells; bracts longer on upper side, at fertile joints as long as sporangium. Antheridia large, .25–.30 mm. in diameter, bright orange. Sporangia *long* and *narrow when young*, crown large and spreading, oval and black when mature.

This is one of the largest species of Chara, and is of special interest as being the only American species without cortication.

In Herb. Gray a fragmentary specimen from Oregon (E. Hall) and another, in a more perfect state from Hillsborough. N. C., represent the species. We have found it abundant at Jamaica Plain, and it grows in other localities near Boston.

On account of its large size and freedom from corticating cells this species is favorable for the study of the circulation of protoplasm.

Var. **Schweinitzii** A. Br.

Plants rather *small*, not exceeding a foot in length, pale green; whorls of *leaves numerous*, forming a *dense spike* at the *end* of the branch; leaves *broad*.

This is strictly an American form. A foreign variety, *C. Braunii*, which appears to be quite common in Europe, is much like our variety. J. Wallman considers them the same in his " Famille des Characees" p. 49.

The variety is a common and constant one with us. In Herb. Gray, it is represented by Nos. 10, 11, 13 and 15 of C. Wright's New Mexico collection; the West is represented by members from Oregon, (E. Hall). An old specimen from the herbarium of J. Gay was collected in Pennsylvania, in 1837. Brattleboro, Vt. (Frost); Salem, Mass. (Robinson); Appanaug Pond, R. I., and Uxbridge, Mass. (Dr. Robbins). The finest of all the specimens as regards size, color and abundance of fruit were from Wood's Holl (Dr. Farlow) where it grows in shallow ponds. On these latter specimens well developed bulblets were found, thus adding this species to the list of those which reproduce by that method.

Chara crinita Wallr.

Chara crinita Wallr. Agardh. Syst. Alg., 126; A. Braun, in Flora, 1835, I, 70; Kütz., Phyc. Germ., 259; Sp. Alg., 525; Wallman, Char., 91; A. Braun, in Krypt. Fl. Schlesien.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 6, 65, 66, 67, 68 and 69.

Plants diœcious, one to two feet in length, incrusted with lime; stem .68–.80 mm. broad, *spines very numerous*, mostly in *rosettes*, stipular ring *double*, large, *corticating cells same number* as *leaves*; whorls consisting of 6–8 leaves; leaves with 6–7 articulations *corticated to the apex* and ending in a *whorl of bracts*; bracts acute, 1–1.5 times the length of the sporangium. Sporangia numerous, large, long and narrow, 11–13-striate, crown short, spore jet black.

This is a rare species in the United States, the only specimens we have seen having been collected by Dr. Robbins near Uxbridge, Mass. Mr. Allen states that it has been found at Montauk Point, Long Island.

Nordstedt and Wahlstedt's Char. Exsic. is rich in this species, but no male plants are present, and the same is the case with Braun, Raben. and Stiz. collection.

The Uxbridge plants, as also those mentioned by Mr. Allen, are all female, showing that with us the species is perhaps parthenogenic as it is supposed to be in Europe.

The species is subject to considerable variation. Many of the Scandinavian specimens are much smaller than ours, profusely covered with spines, bright green and almost velvety in appearance, and altogether among the most attractive of the species. Among the most noticeable forms are *C. condensata* a contracted form, and *C. perpusilla* (*Chara pusilla* Flörk) which is thoroughly fruited, and not over an inch in length. Their "forma laxior" most nearly agrees with the American representatives. The species is a near relative of *C. aspera*, but may be distinguished from it by the upper articulations of the leaves, those of the latter not being corticated.

Chara ceratophylla Wallr.

Chara ceratophylla Wallroth, Fl. Crypt. Germ., II, 113; Sprengel, Fl. Halensis, 438; A. Braun, in Flora, 1835, I, 65; Schweiz. Char., 18; Agardh, Syst. Alg., 128; A. Braun, in Krypt. Fl. Schlesien, 404. *Chara tomentosa et ceratophylla*, Kütz., Sp. Alg., 526; Wallman, Char., 89.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 8.

Illustration: Fl. Dan. x, Tab. 1656.

Plants *diœcious, very large size*, incrusted with lime, stipular ring *large* and *spreading*; stem 1.0–1.4 mm., broad, bearing *many long loosely hanging spines*; whorls remote, consisting of 5–8 leaves; leaves 6–8 cm. long, corticated to near the apex, lower articulations fertile and provided with long bracts exceeding the length of the sporangium. Sporangia .55–.65 mm. long, *crown contracted*, spore black.

A quantity of the male plant was collected by Mr. Wright in New Mexico; and the female has been sent from Florida. This comprises the list of American specimens and their localities as far as we have been able to determine.

No. 8 of Braun, Raben. and Stiz. Exsic., agrees with our plants except that it is more incrusted with lime, a characteristic quite common among the European plants. The specimens from New Mexico are quite free from calcareous incrustations, and are of a pea-green color.

Chara aspera (Deth.) Willd.

Chara aspera (Deth.) Willd., Agardh, Syst. Alg., 130; Sprengel, Halensis, 437; A. Braun, in Flora, I, 71; Schweiz. Char., 20; Kütz., Phyc. germ., 257; Phyc. gen., 320; Sp. Alg., 521; Coss. and Germ., Fl. Env. Par., 680; Babington, Man. Bot., III, 422; Wallman, Char. 94; A. Braun in Krypt. Fl. Schlesien, 408.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 11 and 12.

Illustrations: Engl., Bot., Tab. 2737; Fl. Dan., Tab. 1940; Coss. and Germ., Atlas Tab. 38–D; Greville, Scot. Crypt. Fl., VI, Tab. 339.

Plants *diœcious*, slender, much branched, incrusted with lime; stem .50–.65 mm. broad, *spines very numerous*, stipular ring *large*; whorls numerous, consisting of 6–8 leaves; leaves with 6–7 articulations, the *upper 2–3 naked*, ending in a *mucronate tip*; bracts sharp pointed, as long as the sporangium. Sporangia .46–.55 mm. long, *three times* as long as broad, *12–14-striate*, crown short, truncate.

The slender habit of growth, diœcious character, and numerous spines, make this one of our most distinct species. It has been found to some extent in nearly all regions of the earth, and is one of a few species which grow in both fresh and salt water.

The "forma marina" of Nordstedt and Walhstedt's collection agrees with No. 12 of Braun, Raben. and Stiz. Exsic., which is also from the sea, in being provided with bulblets.

In Herb. Gray the specimens are from New Mexico (Mr. Wright, 16–17), and correspond to No. 11 of Braun, Raben. and Stiz. Exsic., and are of the normal form. According to Mr. Allen this species has been found at Montauk Point, Long Island, along with *C. crinita*.

Chara Robbinsii n. sp.

Plants monœcious, yellowish green, without incrustation, branching only at the lower leafless nodes; stem not exceeding eight inches in length, .25–.40 mm. broad, slightly spinose, *stipular ring large*; whorls numerous, consisting of 8–12 leaves; leaves 1–2 cm. long, with *basal articulation naked*, and nearly *one-third* of the *length* of the *leaf*. The *three* lower *nodes fertile* and the *internode above* each, *corticated*; *upper* portion of leaves *without cortications* and ending in a *whorl* of *large bracts*. Antheridia small. Sporangia long, with large *spreading crown*, spore jet black.

The plants which answer to the above description are more nearly related to *C. gymnopus* than to any other species. They differ from that species in being less than half as large, and having the upper portion of the leaves free from cortication. The bracts are much broader and longer than in *C. gymnopus*, and the stipular ring is more conspicuous. Besides these differences, the much greater length of the naked basal cell of the leaves of these plants, justifies their separation as a distinct species.

The plants were collected in Apponaug Pond, Rhode Island, and appear among the unnamed specimens received from Dr. J. W. Robbins, after whom we take pleasure in naming the species.

Chara gymnopus A. Br.

Chara gymnopus A. Braun, Schweiz. Char., 23; Char. Afrik., 874; Char. Australis, Hook. Jour. Bot., 1849, I, 203.

Plants monœcious, slightly incrusted with lime, yellowish green; stem 40–50 mm. broad, *spines few*; whorls remote, 7–12 leaves; leaves with *basal articulation naked*, otherwise entirely corticated, *apex* of *five sharp unequal* cells, articulations 8–10, bracts at fertile joints equal in length to sporangium. Sporangia oblong .40–.50 mm. in length, 10–12-striate, crown short with a *broad top*.

The species was founded on specimens which were collected in Egypt. It is not found in Europe. With us *C. gymnopus* is rather common, and is subject to considerable variation.

In Herb. Gray: No. 5, 7 and 8 of C. Wright's New Mexican collection; Western Texas, (Wright, No. 2); Fredericksburgh, (F. Lindheimer, No. 478); the most northern locality being Potomac River; the exact point not given.

Var. **elegans** A. Br.

Stem .75–.90 mm., broad, with numerous long spines; whorls remote below, approximating above into a *large head*; bracts at fertile joints *two* to *three times* the length of the sporangia, those at the sterile joints *exceeding* the length of the articulation next above. Sporangia *large*, .55–.70 mm. long, crown .25–.30 mm. broad.

This variety differs from the normal form in being larger; the whorls composed of longer leaves, which are collected into terminal heads; bracts much longer and more numerous, and the sporangia somewhat larger. On account of its freedom from calcareous incrustation, compact cortication and general cleanliness of habit this variety is the finest of our American Charas, and well merits the name of *elegans*.

The var. *elegans* seems to have been first found in America by Oakes. In the Gray Herbarium is a specimen collected by him which, however, bears neither date nor locality. It probably came from Essex Co., Mass., where the variety has been recently rediscovered by Mr. John Robinson, who reports that it is rather common in Chebacco Lake. There is also, in Herb. Gray a paper of specimens of this variety collected by Dr. George Thurber, locality not given. It has also been found at Peekskill, N. Y., according to Mr. Allen.

Among the specimens in alcohol sent by Mr. Robinson a deviation from the variety form was found. The difference is confined entirely to the leaves, the more slender nature of which, as well as its much shorter bracts at the sterile joints, are noticeable. The excessive length of the bracts around the sexual organs is in contrast with those in the ordinary form. The most striking peculiarity of the plant is its not bearing both sexual organs at the same joint. Usually a single sporangium and antheridium were found on each leaf, sometimes two sporangia and no antheridium, or two antheridia and no sporangium; but never more than two of these organs on a leaf, and they at the second and third joints from the base. This arrangement of the sexual organs may be considered as steps towards a diœcious species, first in the separation of the organs to different joints and then to different leaves. This form is of great interest, and would furnish a fine subject for study to one who loves such deviations and can procure an abundance of specimens.

Chara fœtida A. Br.

Chara fœtida A. Braun, in Flora, 1835, I, 63; Schweiz. Char., 14; Coss. and Germ., Fl. Env. Par., 697; A. Braun, in Krypt. Fl. Schlesien, 406. *Chara vulgaris* Linn., Wallroth, Fl. Crypt. Germ., II, 110; Agardh, Syst. Alg., 128; Sprengel, Fl. Halensis, 437; Kütz., Phyc. gen., 319; Phyc. germ., p. 258; Sp. Alg., 523.

Exsiccatae: Braun, Raben. and Stiz. Char. Exsic., 82.

Illustrations: Engl. Bot., V, Tab. 336; Coss. and Germ., Atlas, Tab. 37, A.

Plants monœcious, incrusted with lime; stem .55–.70 mm. broad, distinctly striate, *spines small*, *arising from the furrows*, stipular ring *small*, *double*; whorls rather numerous, composed of 6–10 leaves; leaves corticated except the upper articulation, which ends the leaf in a *sharp point*; bracts four at the fertile joints, *two as long* as, and *two longer* than, the sporangium. Sporangia oblong, .46–.80 mm. long, 11–14-striate, crown contracted, spore brown.

Including all its varieties, this is a widely spread and common species. In Europe the normal form is not so frequently found as some of the varieties. In Sweden it is rare, according to J. Wallman in his treatise on the Charæ of that country, and the statement accords with the inference to be drawn from Nordstedt and Wahlstedt's Scandinavian Characeae, in which not one of the thirty specimens is of the specific type. In the United States quite the reverse is true.

In Herb. Gray: Diamond Valley, Nevada, (Watson); New Mexico (C. Wright, No. 14), and (A. Fendler, No. 1026); Santa Barbara Co., California (Dr. Torrey); San Diego Co., Cal. (Dr. Palmer, No. 437). Ames, Iowa (Prof. Bessey). The species is probably more common in the South and West than in the East.

Var. **longibracteata** A. Br.

Chara fœtida, *var. longibracteata*, A. Braun, Schweiz. Char., 15; Coss. and Germ., Fl. Env. Par., 697. *Chara longibracteata*, Wallman, Char., 65. *Chara vulgaris*, *var. longibracteata*, Kütz., Sp. Alg., p. 306; Phyc. gen., 319; Phycol. germ., 258.

Exsiccatae: Braun, Raben. and Stiz. Char. Exsic., 83.

Illustrations: Coss. and Germ., Atlas Tab. 37, I; Kütz., Tabulae Phycol., VII, Tab. 60, I.

Leaves long, corticated for only a part of their length, upper portion with whorls of long bracts; bracts at fertile joints 2–3 times the length of the sporangia.

This variety, as the name indicates, is characterized chiefly by the great length of the bracts; but it also differs from the type in being smaller, whorls more numerous, and of a greener appearance. This is the common variety of Europe. With us the localities where it has been found are few, though bounding a wide extent of country.

In Herb. Gray: New Mexico, (C. Wright, No. 3). Specimens were received from Prof. Bessey, Ames, Iowa, and Prof. Dudley, Ithaca, N. Y. Even among these few plants some variations are noticeable.

Var. crassicaulis A. Br.

Chara fœtida, var. crassicaulis A. Braun, in Flora, 1835, I, 64; Kütz., Phyc. Germ., 258; Sp. Alg., 523. *Chara longibracteata* var. *crassicaulis* Wallman, Char., 65.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 69.

Illustration: Kütz., Phycol., VII, Tab. 60.

Plants densely incrusted with lime, and very brittle, giving off a disagreeable odor, whorls remote, consisting of 5–8 short, thick leaves. Sporangia small.

A very fragile and homely Chara, most frequently found in limestone regions.

In Herb. Gray, Gunnison, Utah, (Powell's Survey); New Mexico, (C. Wright, 22, 23); Illinois, (Prof. Vasey). The most luxuriant specimens were sent from Union Springs, N. Y., (Miss Ladd), and Battle Creek, Mich., (Mr. Wilson).

Chara contraria A. Br.

Chara contraria A. Braun, Schweiz. Char., 15; Wallman, Char., 76; Kütz., Phycol. Germ., 258; Sp. Alg., 523; A. Braun in Krypt. Fl. Schlesien, 405. *Chara fœtida*, var. *contraria* Coss. and Germ., Fl. Env. Par., 890.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 37 and 38.

Illustrations: Coss. and Germ., Fl. Env., Par., Atlas, Tab. 37, F. 8; Kütz., Tabulae Phycol., VII, Tab. 61.

Plants monœcious, incrusted with lime, slightly branched, stem *spirally striate* .50–.75 mm. broad, *spines springing from the projecting cortical cells*, minute, and *numerous* in the *younger* portions; stipular ring *conspicuous*; whorls remote, of 6–10 variable leaves; *upper* portion of leaves *not* corticated and ending in an *obtuse* point, bracts longer than the sporangium. Sporangia .55–.65 mm. long, 12–16-striate.

This species is closely related to the preceding, and is considered only a variety of it by Cosson and Germain in their latest edition of Flor. dés Env. d' Paris. J. Wallman, Alex. Braun, and others agree that *C. contraria* and *C. fœtida* are much alike, but consider the position of the spines a good distinction. A difference is also noticeable in the younger portions of the plants. In *C. contraria* the young naked leaves overarch the apex and form heads suggesting those of *Nitella nidifica*. *C. fœtida* has the young leaves more corticated and spreading.

Nordstedt and Wahlstedt's collection is rich in this species; several minor deviations from the type are noticed but no varieties are formed. The species seems to be as wide-spread as *C. fœtida*; and according to Alex. Braun often grows with it.

In Herb. Gray, No. 4, 6 and 9 of Mr. Wright's from New Mexico represent the species. It is mentioned by Mr. Peck, in the 23d Report of the Botanist of New York, as being found in Cedar Lake, Herkimer Co., N. Y.

Chara fragilis Desv.

Chara fragilis Desv., A. Braun in Flora, 1835, I, 68, Schweiz., Char., 2; Wallman, Char., 101; Kütz., Phyc. Germ., 257; Sp. Alg., p. 521; Coss. and Germ., Fl. Env. Par., 680; Babington, Man. Bot., 11, 422; A. Braun in Krypt. Fl. Schlesien. *Chara pulchella* Willd., Agardh, Syst. Alg., 129.

Exsiccatae: Braun, Raben. and Stiz., Char. Exsic., 13.

Illustrations: Engl., Bot. Tab., 2767; Coss. and Germ., Atlas, Tab. 38, Thuret., Ann. Sc. Nat., III, 18, Tab. 8 and 9.

Plants monœcious, slender, incrusted with lime, corticating cells long, *three times* the *number* of the *leaves* in the whorl next above, spines undeveloped; whorls numerous, 7–9 leaved; leaves closely corticated except 1–2 extreme articulations and *ending* in an *obtuse point*; bracts mucronate, long as sporangium. Sporangia ovoid, 13–15-striate, crown *long*, *conical*, spore black.

Throughout Europe, next to *C. fœtida*, this is the most common species. It has a number of well-marked varieties, some of which are much more common in the United States than the specific type.

In Herb. Gray, Monterey, Cal., (Bolander). It has also been found at Norfolk, Conn. (Dr. Robbins); Pleasant Pond, Essex Co. (Robinson), and Litchfield Lake (Allen).

Var. **delicatula** A. Br.

Chara fragilis, var. *delicatula* A. Braun in Krypt. Fl. Schlesien, 411. *Chara delicatula* Agardh, Syst. Alg., 129.

Plants but little incrusted with lime, dark green; joints of leaves often dark; bulblets present.

The absence of calcareous incrustation and more slender habit readily distinguishes this from the specific type. Those bearing bulblets have sometimes been placed as a sub-variety; *bulbulifera*.

Var. **major longifolia** A. Br.

Chara fragilis var. *major longifolia* A. Br. *Chara Hedwigii* Agardh, Syst. Alg., 129. *Chara fragilis* var. *Hedwigii* Wallman, Char., 84; Kütz., Phyc. gen., 319. *Chara fragilis* var. *elongata* Kütz., Sp. Alg., 521.

Exsiccatae: Braun, Raben. and Stiz. Char. Exsic., 14.

Plants long and slender, slightly incrusted; whorls remote; leaves 4–6 cm. long. Sporangia large.

This is an elongated form, the stem often obtaining the length of some feet and the leaves are proportionally long. It has been collected at Apponaug Pond, R. I., Hartford, Conn., and Worcester, Mass., by Dr. Robbins. The large size of the sporangia in contrast with the slender leaves and stems is quite marked.[1]

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MUELLER, K. " Zur Entwickelungeschichte der Charen" Bot. Zeit., 1845.

PRINGSHEIM. "Ueber die Vorkeime und die nacktfüssigen Zweige der Charen," Prings., Jahrbucher III, p. 394.

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[1] Besides the species above described three others are mentioned in a Class-Book of Botany by Alphonso Wood, 1854; *C. foliosa* Willd., *C. humilis* Riddell, and *C. sabulosa* Riddell. We have seen no specimens of these species and, as the descriptions in the work referred to are inadequate, we have not included them in the present paper.

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GROWTH AS A FUNCTION OF CELLS. BY CHARLES SEDGWICK MINOT.

The phenomena of growth in all metazoic animals must be regarded as functions of the cells, derived from the primitive egg-cell,— the impregnated ovum. The discussion of growth from this stand-point has not, as far as I am aware, been hitherto attempted. In the following pages I offer for consideration the arguments and conclusions I have gathered as to the factors which determine growth.

The measure of growth usually adopted is the weight of the body— but this does not determine necessarily the increase in the amount of living matter, because not only does the protoplasm of the cells increase, but also the intercellular substances, the non-living matters enclosed in the protoplasm, and the water with which the albumenoids are imbibed. Evidently unless the proportion remains the same between the vitalized and the dead substances the weight of the body does not indicate with exactitude the amount of the living matter— yet this would certainly be the most satisfactory measure of growth. If, on the other hand, we regard the individual cell as the structural unit and do not lay much stress upon the distinction usually drawn between the protoplasm and the deutoplasm, it would be sufficient to determine the number of cells at successive periods. At present at least we have no means of actually counting the cells of the body. Nor can we calculate the number of cells by dividing the total volume of the body, which could be readily measured, by the volume of a single cell, because the cells united in one body are of various sizes. This difficulty could be surmounted if we knew the average proportions of the cells; we are again baffled by the impossibility of determining this average. Moreover another point demands consideration, namely, that the number of cells united in the body of an animal at a given moment, when the size is to be measured, is less than the whole number of cells produced up to that time, because a variable number have died and fallen off. In man and many animals the loss at one time is small — the epidermis, for instance, scales off gradually,—in forms which moult the loss at each moult is considerable, while in starfishes, for example, an accident may cause the loss of several arms, equal collectively to half or more than half of the total weight. In weighing, these losses are not taken into account.

These considerations suffice, I think, to demonstrate that the weight of an animal is not an entirely accurate and satisfactory measure of growth, although practically it is our best standard. The weight of the body then represents the sum of the weights of the total number of cells united in one individual at a given time. In making this statement we assume that the intercellular substance is part of the single cells, an assumption which seems to me perfectly justifiable, as long as we maintain that the intercellular substance is generated by the cells. The weight then in short depends on: 1°, the number, 2°, the size of the cells—two variables which are to be determined.

In a previous paper[1] I endeavored to prove that all Metazoa (and probably all Protozoa) pass through successive cycles, each cycle beginning with the impregnated ovum, passing through youth to old age, and ending with death. Before death ensues, however, the sexual products are generated, and produce by their union a single cell, with which a new cycle begins. This cell multiplies itself, and therewith growth is accomplished. Two fundamentally different processes here display themselves: the gradual *senescence*, which continually hinders and delays the multiplication of the cells, and their vital acts, at last suppressing them altogether at the moment of death; before senescence conquers, the sexual products are thrown off and effect the process of *rejuvenation*. The old cycle of cells passes away, but a new cycle is developed, a new egg-cell is produced, endowed with an extraordinary power of division. Evidently all the cells resulting from one impregnated egg belong in one cycle — a view identical with that advanced by Huxley in his paper[1] on animal individuality. Huxley maintained that all the animals or parts arising from one egg represent collectively but a single individual. Huxley's idea appears to me extremely valuable, although it seems to me that the use of the word individual is unfortunate and that cycle is less misleading. Individual is ordinarily used in the same sense as "*person*" is now employed by Haeckel and his followers; I would therefore suggest *biad* as a still more appropriate term to designate a separate animal (or vegetable) existence. Thus each Protozoon is a unicellular *biad*, every Coelenterate or Bryozoic zooid, and every individual of the higher animals, whether produced organically like the Aphides, or the budded Naids or not, is a *biad*. The point to which I wish to call attention is that the number of *biads* in one cycle of cells varies; in Hydroids, Bryozoa, Cestods, Nais, many Tunicates, Aphis, etc., there are several; in other, especially the higher, animals there is one biad. Growth may be defined as a function of the rejuvenescence effected by impregnation; hence to measure growth the whole number of cells living at a given time must all be taken into account, no matter whether they are so arranged as to form one, several, or many *biads*. The growth of a single Hydroid cannot be compared with that of a mammal, but only the growth of a whole colony can be compared, otherwise the comparison is not made between phenomena of the same category.

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[1] Recent Investigations of Embryologists. Proc. Bost. Soc. Nat. Hist., XIX (1877), 167.

Incidentally, I will express my opinion that it is incorrect to say: — the impulse or stimulus to develop proceeds from the spermatozoon. That expression was allowable only so long as it was undecided whether the spermatozoon merely influenced the egg, or also actually united with it. Since we must now probably regard actual fusion of the two elements, male and female, as the universal means of fecundation, we can no longer assume that the egg is passive and the semen an active stimulus. Certainly, because the egg does not move and the spermatozoon is active, is no reason at all for saying that in the entirely different functions of growth the same relative passiveness and activity exist. Probably neither one nor the other sexual product can properly be called the stimulus, but it must rather be said, the impulse to divide arises from the fusion of the spermatozoon with the egg. The moment of fusion, then, is the moment when growth of the new cycle begins.

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[1] Edinb. New Phil. Journ., LIII (1852), 172.

From the impregnated egg are born successive generations of cells; now the process of division necessitates the disappearance of the parent generation, so that two generations of cells cannot exist at once, *except* when they are of different lineage. If all the members of each cell generation were born after the same interval then growth would proceed by jumps; that it does not do so is due to the fact that some cells are formed later, others earlier than the rest of their generation, hence it comes that alongside of cells of the n^{th} generation there may exist others belonging to the $n \pm 1^{th}$, or to the $n \pm a^{th}$ generation. Thus it comes that we can say merely, that at a given moment the cells of the body belong to the n^{th} generation, *upon the average.* Upon this basis it becomes perfectly accurate to say that the phenomena of growth depend upon the succession of cell generations. Starting from this conception I think the following factors may be established.

1. *The number of cells increase in geometrical ratio.* Although there may exist in the body at the same time cells belonging to generations which, counted in the order of their numerical sequence, are some previous, some subsequent, to the ninth generation, or that generation to which the average of the cells belong, nevertheless there is no inaccuracy in saying that at a given time the number of cells depends upon the number of the generation. This unequal rate of division is very important in determining the course of embryological development, being indeed as I have elsewhere shown (l. c.) the most marked characteristic distinguishing the ectoderm from the entoderm. To return: we may assume that the number of cells is doubled at every division, the least possible increase (to the slight inaccuracy of this assumption I shall recur); according to it, the generations would run 1, (egg cell) 2, 4, 8, 16 and so on. At a given time or after n divisions there would be one cell, put $= z$, the basis of the progression, multiplied by b, the ratio (in this case $b = 2$) raised to the $n - 1^{th}$ power: —

n^{th} generation of cells $= z\ (b^{n-1})$.

2. *The rate of multiplication increases.* This is a corollary of the proposition that the multiplication of the cells is a geometrical progression; since however growth is not indefinite, this increase must be counteracted by some means. The cessation of growth is doubtless partly to be accounted for by the death and loss of a portion of the cells, such as we know to occur in the epidermis and some other parts, but we have no reasons for supposing that this loss increases so

as to continually counterbalance the multiplication of the cells. Let $a =$ number of cells lost, then the n^{th} generation $= zb^{n-1} - az$.

3. *The intervals between the births of two successive generations continually increases*, or, in other words the frequency of the divisions continually diminishes. From our point of view this change is the most important alteration produced by senescence; that it really occurs is not only a deduction, but is also shown by actual observation; for no one can question that the division of the cells during segmentation of the yolk proceeds at shorter intervals than during adult life; thus in an egg say 8 or 10, perhaps more, generations of cells may be born in the course of a single day, all the cells dividing; but we cannot for an instant imagine that all the cells of the human adult, for example, divide upon an average even once a day,—more probably a new generation of cells does not appear in an adult animal as often even as once a year. Possibly the rate at which segmentation occurs may offer an opportunity of discovering the rate at which the intervals between the divisions increases, but at present at least it is impossible to determine the frequency of the divisions either in the adult or the embryo; all that we know is that the frequency diminishes.

We have next to consider growth as a function of the time; we will construct a formula in which the *abscissae* x shall equal the time and z the ordinates, the number of cells. Let $x =$ the interval between impregnation and the first division and let it be the unit of time. Let c^{n-1} be the coefficient of senescence, which determines the increase in the intervals between the generations of cells. I have given it the exponent $^{n-1}$ merely to suggest to the eye by the formula that the senescence rises with each generation. c is not necessarily a constant even for a given individual, but may be the product of variable factors—these factors, which determine the course of the development of senescence, are unknown. The n^{th} generation then will exist at the following time after impregnation:

$$x + xc + xc^2 + xc^3 + \ldots\ldots\ldots + xc^{n-1} = \frac{x\,(c^n - 1)}{c - 1}.$$

The time of the existence and the number of cells of the n^{th} generation are given by the following formula:—

$$\frac{x\,(c^n - 1)}{c - 1} = xb^{n-1} - az.$$

$$\text{hence}:\ x = \frac{c - 1}{c^n - 1}\,(zb^{n-1} - az)$$

which determines the number of cells existing at a given time after impregnation.

We turn now to the consideration of the weight of the cells, which varies in several definite ways.

4. *The weight of the cells diminishes at every division and again increases until the cells regain approximately their original size.* This proposition becomes evident upon the mere comparison of the tissues of adult and young individuals of the same species, for we find that the cells retain about the same dimensions, although the size of the cell diminishes by half at every division, because the whole amount of matter originally in one cell separates into two. To counteract this repeatedly recurring diminution the daughter cells must grow up again to the parental size — in the case of unicellular animals, in the embryo, in cartilage, etc., it can be actually seen that this restoration of the size occurs. We must regard this periodical vacillation as a general phenomenon.

5. *The weight of the cells may alter in one direction during several generations.* That in the course of development the cells do essentially change their size is evident from the fact that the cells of each germ-layer of the embryo are all of about the same size, while in the adult and differentiated tissues, the size varies greatly. Studies upon the exact succession of these changes have been published upon man by Harting[1] and upon insects by the two Landois,[2] the only special investigations upon this subject with which I am acquainted. Probably however the changes in one direction are counterbalanced by changes in the opposite direction in other cells, and in any case the *average* weight of the cells cannot alter to any great extent.

There is, however, one very important exception. The egg is always greatly larger than the histological elements either of its parent cycle, or of its own cycle. During the process of segmentation the diminution in the size of the cells continues for a considerable number of generations, during which there is either no, or at most a very slight, change in the total weight of the embryo; hence also the diminution increases as the cells multiply, until the normal size of the elements is reached, when the enlargement of the single cells counterbalances the diminution of size at each division, as above described. This law applies I believe to all the Metazoa, with the exception of the sponges. On another occasion I hope to show that similar alterations of size play the part of an important factor in the development of epithelium.

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[1] Harting. Recherches micrometriquer dur le Develop. des Tissus et des Organes du Corps humain. Utrecht. 1845.

[2] Landois. Zeitschr. f. wiss. Zool., XV, (1865), 307.

6. *The same cell may vary in weight.* Such variations occur (1), through alterations produced by the normal functional activity of the cells: such alterations have for instance been observed by Heidenhain, Kühne, and many others in the cells of the salivary and pancreatic glands; (2), through changes in the non-protoplasmatic portions of the cells, as when water is lost or accumulated by the tissues, or when the fat varies. These variations are very great, yet by confining our attention to the average weights, we conclude that the cells diminish rapidly in size during the segmentation of the yolk, and afterwards change but little if at all — thus marking off two distinct periods: the first short, the second long.

Our previous formula was for the *number* of cells entering into the composition of the body at a given moment of time. To determine the *weight* of the body, the total number of cells must be multiplied by their average weight. Let y be the unit of weight and wy the weight of a single cell. Now, this weight is not constant but varies as a function of the time, hence we must multiply the number of cells into $\cdot f\,(w)\,y$. Therefore: —

$$x = \frac{c - 1}{c^{n-1}}\,(zb^{n-1} - az) \cdot f\,(w)\,y$$

in which

x = interval between impregnation and first division, or the unit of time.
c = coefficient of senescence, which determines the frequency of the divisions.
z = number of cells originally = one egg-cell.
b = ratio of multiplication.
n = number of cell generations.
a = number of cells lost.
y = unit of weight.
wy = weight of single cell.

We now have an equation for determining the curve of growth as indicated by the weight of the body. This equation cannot be said to have any mathematical value, because of all the quantities we know exactly and certainly only the time x and the number of cells ($z = 1$) when growth begins. Nevertheless I have constructed the formula, because each letter being a symbol for a factor that would otherwise be described by a whole sentence, the formula is much more concise and renders the relations of the factors evident at a glance, when the meaning of the symbols has been learnt. It shows that the weight of the body, leaving out of account the cells which die and fall off is determined by

1, the number of cells.
2, their average weight.

The number of cells is determined by

1, the ratio of multiplication; *i.e.*, the number of cells produced at each division.
2, the frequency of the divisions, *i.e.*, the rapidity with which the successive generations follow one another.

Hence the weight is determined by —

1, the ratio of multiplication.
2, the frequency of division.
3, the weight of the cells.
4, the loss of cells.

The fourth factor probably varies greatly in different individuals, even of the same species, and is partly if not mainly determined by external circumstances. The first factor is probably almost constant, and would therefore, if acting alone, cause the growth to be a geometrical progression, presupposing that the daughter-cells attain the parental size after each division. The ordinary method of the multiplication of cells is by division into two daughter-cells. In various instances however the number of cells arising at once from the parent cell is much greater (large cells of medulla of bone, the *Blutinseln*, upper ends of the ovarian tubes of insects, etc.). But these exceptions are rare, and cannot result in any great departure from the average value of 2 +, for the number of cells produced at each division. It cannot be less than 2. The second factor is a function of senescence, and as far as I am aware has never before been alluded to. If its existence is as real as I believe, its importance is fundamental, and should be especially emphasized, because it introduces us to a peculiarity in the manifestations of vital activity, which has hitherto remained unnoticed. Senescence probably exhibits itself in other ways, in senile degeneration of the cells, but it need not be conceived as an active process, but is rather to be regarded hypothetically as due to the gradual fading out of the impulse evolved at the moment of impregnation. We have no reason for thinking that senescence is a distinct phenomenon, from the gradual disappearance of the rejuvenation. The third factor, the weight of the cells, diminishes rapidly at first, then remaining nearly constant. The rapid changes occur in the earliest embryonic period, hence we conclude that in *post*-embryonic growth the main factors are (1), the rate of multiplication, (2), the senescence. These therefore are the most important to us, since it is only post-embryonic growth which we can readily study. The growth of animals has been measured in very few cases. Of recent investigations I will refer especially to those of Semper[1] on *Lymnaeus*, which are not so generally known as they deserve. The observations upon man are more extensive and reliable. By far the most valuable and trustworthy are the statistics published by Gould, and the recently published paper by Dr Bowditch. The older observations of Quetelet are, as we know through Bowditch[2] and Paghiani[3], inaccurate, because he tabulated only picked cases. This is to be especially noted because the conclusions of Quetelet are very generally repeated in text books, and even in the second edition of Foster's Physiology[4].

It is probable that the rate of growth in weight increases for about half the period of growth, then remains approximately constant for a short time and finally slowly diminishes until it becomes zero. Whether in all animals the succession of changes is the same the future will decide. In man and some few animals it certainly is so. Of these phenomena, I offer the following interpretation: — at first the increment of senescence is less than the increment of the number of cells at each division, therefore the multiplication of the cells obtains the upper hand, and the rate of growth increases; soon however the increment of senescence surpasses the increment of multiplication and thereby renders the rate of growth less, until at last the excess of senescence becomes so great that growth ceases, or at least becomes so insignificant, that it only serves to counterbalance the loss of cells. Now since the cells multiply in geometrical progression, the senescence cannot increase in geometrical progression also, because then the curve of growth would be a straight line;

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[1] Semper. Arbeiten des zool. zoot. Inst. Würzburg, I. (1874), 137.

[2] Bowditch. Growth of children. Eighth Annual Report of the State Board of Health of Massachusetts. Boston, 1877.

[3] L. Paghiani. Sopra alcuni fattoir dello Triluppo umano Atti. real Acad. Sci. di Torino, XI, (Marzo, 1877).

[4] M. Foster. A Textbook of Physiology. 2d. Edition (1878), p. 556.

on the contrary at first senescence must rise in less than, afterwards faster than in, geometrical progression. As we have seen, senescence affects the different cells unequally, and accordingly some cells are dividing while others are not. In the mature body it appears that a minority of the cells are in process of division while the majority are not.

At the time when senescence has nearly produced a cessation of growth, the animal is mature and the sexual products arise, and accomplish the office of rejuvenation. The intimate connection of maturity and of the development of the eggs and sperma, must lead to the hypothesis of a causal connection which we can express by saying *the exhaustion of the rejuvenating power becomes the stimulus for the formation of the sexual products.* This view is very similar to the theory of rejuvenation among Infusoria, as brought forward by Bütschli in his work on the "*Eizelle.*" Further interesting speculations suggest themselves, but where the phenomena themselves are so vaguely known, speculation is unsafe and must be renounced.

The curve of growth evidently determines the size of the animal, for at the time when the rate of growth of the body in weight becomes zero, the animal has attained its maximum size. It appears to me a perfectly safe conclusion that in small animals the senescence gains the mastery quicker than in large animals; otherwise stated, that the juvenescence is less powerful in small than in large animals. Moreover, although we have no very accurate knowledge as to the length of life of most animals, yet in a rough way we know that the larger an animal the longer it lives; this confirms the idea that in large animals senescence proceeds more slowly than in smaller ones. The age and size of animals are thus brought into intimate correlation, but it does not follow that all animals of the same size live to the same age — this, if true, would oblige us to assume that the *original* frequency of the cell divisions, in other words the interval between impregnation and the first division of the yolk is always the same. We must on the contrary conceive that it is very unequal, so that though the senescence of the corresponding cell-*generations* of two species of the same mature size may be equal in quantity, yet in that species in which the original interval was greatest, the n^{th} generation will come later and therefore that species will be the longer lived. I insert these remarks to avoid the possibility of conveying the impression that I should expect to find, according to my theory, a rigid correspondence between size and age.

In small animals then the number of cells in a single cycle is less than in large animals. To avoid misapprehension I must recall that the size of animals is not a true index of the number of cells in their bodies, for in different species the size of the cells often varies; for example, the cells are very small in starfishes, but very large in frogs, two animals of about the same bulk, but evidently composed of widely different numbers of cells.

From all these considerations we are forced to attribute *a different and characteristic value to the coefficient of senescence in every species of animals. Since the rate of multiplication of the cells is about (if not exactly), the same in all animals, the variations in the natural size and length of life in animals must depend first, upon the coefficient of senescence, second, upon the original interval between the cell generations, or the length of life of each generation.* The specific curve of growth may be altered by external circumstances, as when a poorly fed animal remains undersized.

As far as I can judge the whole series of views here advanced must apply with equal force to plants, if the terms egg and spermatozoon are replaced by the proper equivalents. Upon this point, however, I can venture no decided opinion, but leave the decision to others.

In many cases it is much more convenient to measure the length of the animal than its weight, and it is therefore important to decide whether the rate of growth can be determined by measuring *one* dimension. As the body grows in three dimensions of space, it is evident that the length cannot be a just measure unless indeed it always retains the same proportion to the other two dimensions. Probably this proportion is not constant in animals any more than in man. Bowditch, *l.c.*, p. 50–51, has shown that in boys and girls the number of pounds per inch of height constantly increases but very much more slowly than the curves of the diameters — hence we must conclude that the growth in one dimension (height) is enormously greater than in the average of the other two (diameter of the body). Nevertheless the curve of growth in height after the eleventh year, although not really parallel with the curve for the weights (see Bowditch *l.c.*, plate I), is yet similar in its course. The bearing of these facts becomes plainer if it is borne in mind that in reality growth, defined as a function of the multiplication of cells, occurs only in *one* plane. This is proved by the following arguments.

Let us assume that the cells are all spherical, and further that the parent cells divide in two — then the division of each cell can occur only in one single plane. Even if the number of cells produced at one time is greater than two, still as long as they are not more than six in number they can arrange themselves in one plane around the parent cell. In the majority of cases the cells are not spherical nor even spheroidal, but usually compressed, so that a greater number than six cells could arrange themselves in one plane in contact with one another. If the cells instead of remaining in contact with one another, as is usual, could separate, an indefinite enlargement in one plane could occur. We say therefore: *The multiplication of every cell occurs in one plane only; if the planes for all the cells of one body were parallel, then the growth of the body would be confined to one plane;* since however the planes of division for the neighbouring cells are not parallel but vary towards all three dimensions of space, therefore the body grows in all directions. It now becomes evident that if the proportion of the cells dividing in each one of the three dimensions remains nearly the same throughout life, then determining any one dimension of the body must give an approximately accurate curve of growth — a conclusion of practical value rather than of theoretic importance.

The relation of the planes of divisions of the single cells to one another is, as I may incidentally remark before concluding, an extremely important factor in the processes of histological differentiation, a subject which I hope shortly to discuss elsewhere. Thus in all epitheliums, composed of only a single layer of cells, the plane of division must be parallel to the surface of the epithelium. In the early stages of embryonic life, for instance in the epiblast, which really is an epithelium, the division of the cells has, especially in invertebrates, been again and again seen to occur in a plane parallel to the surface of the layer. To give one more example, in nerves the plane of division must be parallel with the fibres. I think there can be no question that for every tissue there is a special and characteristic relation of the planes of division of the single cells to one another. The further discussion of these relations must be foregone as aside from the objects of this article.

It remains for me to express my thanks to Dr. H. P. Bowditch, and to Prof. Chas. R. Cross for their valuable hints and suggestions.

General Meeting. March 19, 1879.

The President, Mr. T. T. Bouvé, in the chair. Seventeen persons present.

Dr. B. Joy Jeffries read a paper on various phenomena of color blindness and color perception.

Prof. P. F. Reinsch described some supposed microscopic organisms, observed in slate from low strata of Silurian formation in Illinois, and from the anthracite coal of Pennsylvania.

General Meeting. April 2, 1879.

The President, Mr. T. T. Bouvé, in the chair. Forty-three persons present.

The following papers were read:

PRELIMINARY NOTICE OF CERTAIN LAWS OF HISTOLOGICAL DIFFERENTIATION. BY CHARLES SEDGWICK MINOT.

The following article contains certain results, which I think may be safely deduced from various data, familiar to histologists. It has been my effort to formulate such general laws relating to the processes of histological differentiation, as I could gather either from the writings of others or from my own studies. Some of the conclusions thus formulated, I now publish in the hope that they may prove of some interest and value to others.

1. *The most primitive form of tissue is an epithelium composed of a single row of polyhedral cells of equal height.* It is well known that the two germinal layers in all animals, in which they have been studied, first appear as simple epitheliums. There is in the embryonic life of many invertebrate animals a stage, during which the whole body consists solely of epithelial tissues. In the primitive epithelium the cells when viewed from the surface are always irregular in outline, and usually 5–6 sided, sometimes 7 (or perhaps more) sided, but probably never four-sided, except occasionally isolated cells which assume that outline. There is a round or nearly round nucleus in the central part of each cell. In every epithelial cell three axes may be distinguished, two parallel and one perpen-

dicular to the surface of the layer, of which the cell forms a part. In the primitive epitheliums of the embryo these three axes are nearly equal in length, hence the tissue is said to be composed of cubical cells. That these characteristics are true of all classes cannot, I think, be questioned by any one who will consult those embryological memoirs in which accurate histological figures of the early stages are given. That the germinal layers have the characteristics described I can affirm from direct observations of my own upon Toxopneustes, Doris, Lymnaeus, Ancula, Clepsina, Leptoplana. Palaemon, etc., and certain vertebrates. These early features are sooner or later in part obliterated.

2. *Very early in the course of development the ectodermic cells become smaller amd multiply faster than the cells of the entoderm.* This fact, which I have pointed out in a previous publication[1] seems to have hitherto escaped notice. It appears to me to have great importance, for it indicates a definite and fundamental difference between the two germinal layers. The large size of the ectodermic cells is accompanied and perhaps caused by the development of yolk granules, which apparently are almost if not quite confined to the entoderm.

In my article just cited, I have referred to certain observations that do not accord with the generalisation made. To those observations I am still inclined to attach little importance. Since my first paper appeared, a most important exception has been made known. In the sponge embryo, at the time it assumes the characteristic egg shape, there are, as is well known, two distinct parts, which apparently correspond perfectly to the two first layers of the diaderm[2] of the remaining Metazoa,— one half of the larva is composed of comparatively small ciliated cells, apparently the analogue of the ectoderm in other larvæ, and one half of very large cells, charged with nutritive granules, having in short the characteristic features of entodermal cells. F. E. Schulze and Mecznikow both agreed in regarding the large celled layer as entoderm, the other as ectoderm.

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[1] Proc. Boston Soc. Nat. Hist., XIX, 165, (1877).

[2] The term *diaderm* is used to designate that stage in which the two layers entoderm and ectoderm are clearly differentiated. This designation is preferable to any other I know, because it indicates the essential feature, the presence of two distinct layers, that feature which forms the basis of animal morphology. The existence of the *diaderm* is an established fact, while the existence of the Gastrula is at least doubtful in some cases. It must be remembered also that the formation of two layers often precedes the formation of the gastrula.

It was not, however, till recently, that the metamorphosis of the embryo was followed by F. E. Schulze[1], who discovered that the apparent entoderm becomes external in the adult, the apparent ectoderm internal. This very interesting discovery obliges us to hesitate before accepting the distinction drawn between the two germ layers, as given above. Or else we must suppose, either that the distinction is true of only the higher Metazoa, or else that it is true of all including the sponges. The latter alternative is the more difficult to accept, because it involves the conclusion that the apparent ectoderm of sponges is the equivalent of the entoderm of other animals. The difficulty is very serious, the more so as Schulze is so careful and skillful an observer that there is no ground to suspect an error of observation.

The further differentiation of two epithelial germ layers depends on (1) changes in the proportion of the three axes mentioned above; (2) the formation of folds; and (3) differentiation of the structure of the single cells. I shall speak of each of these processes briefly.

3. *The two horizontal axes usually remain approximately equal to one another in length while the perpendicular axis varies independently and to a much greater absolute extent.* I have already said that the original cells are nearly equiaxial, a statement that every histologist and embryologist can readily confirm. In the adult animal, however, the ectoderm varies very much in height. The epidermal cells are low and broad in the Medusae but very high and narrow in Lucernaria, or in Polia, while in Lumbricus they are moderately high. In all vertebrates, except of course Amphioxus, the multiplication of cell-layers in the epidermis introduces a distorting element. So also in the entoderm, the epithelium is at first of uniform height, but as development progresses some of the cells become higher and narrower than at first, or, as in the gastric glands of vertebrates, the cells at the base of involutions become not only higher but broader. It is not, however, necessary to enter into details, which would only lead to the repetition of familiar facts — enough has been said to show that the perpendicular axis is the most variable and independent, while every one who has examined surface views of epitheliums from many organs and species, will recall that although the outlines vary very much, yet the two *horizontal* diameters are, though not equal, at least dimensions of the same order, and so nearly alike, that the familiar designation of cylinder-epithelium is quite justifiable.

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[1] Zeitschr. f. wiss. Zool., xxxi, (1878).

Of the three axes the perpendicular is the most important, so much so that important conclusions may be drawn from the alterations in the height of the epithelium alone. If the original height be determined, then in later stages any departure from that height corresponds to a modification, and if we can safely reason from the henogenetic succession to the phylogenetic, then the earliest animal with distinct germinal layers, must have consisted of two sets of cubical layers. Either an increase or diminution of the perpendicular axis must be regarded as a variation. Let us take the body cavity of vertebrates as an example. The peritoneum is at first a layer of cubical epithelial cells, as has been shown by many authors[1]; throughout its greater extent the cubical cells are ultimately completely flattened, being converted into an endothelium. Along the dorsal surface of the body cavity there are four bands, two on each side, where the layer retains its primitive character for a longer time; the two bands nearest the mesentery form projecting folds, which are converted into the sexual organs. The two outer or lateral bands form furrows, the first development of the excretory system; the differentiation of these organs depends therefore in part on the preservation of the primitive form of the cells. So in many other cases it will be found that in one part of an epithelium the primitive dimensions of the cells are preserved longer than in another part. Another point to be considered in this connection, is that changes in the height of an epithelium are by no means unimportant, but on the contrary they are among the very most important and fundamental of all the changes with which the embryologist has to deal. It is on this account that the nature of the epithelium should be carefully considered in every case. I may incidentally remark that it is for this reason that I have emphasized[2] in my articles on the tracheae of insects the fact that in all the species I have examined the external epithelium of the air tubes is flat. Chun has stated that he found a cubical epithelium, a view which seems to me improbable, for it would indicate that in some species an embryonic peculiarity is preserved, which I know from direct observations has certainly disappeared from closely allied species.

The nervous system, although arising from an epithelium, develops so that the distinction of the axes is lost, but in every true epithelium or endothelium, with but one layer of cells, the distinction is evident.

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[1] I may mention Götte, Balfour, Kölliker, Oellacher and others.

[2] Minot. Arch. Physiol. norm. pathol., III, 1. American Naturalist, July, 1877.

4. *Epitheliums increase their surface by the formation of depressions* (invaginations), *or of projecting folds* (evaginations). This is a familiar principle, and therefore need not be further considered.

5. *Structural modifications of epitheliums usually affect similarly a whole cluster or tract of cells, but rarely isolated cells only.* The illustrations of this principle may be found in every class of animals — as for instance when one area or region of the epidermis is composed of higher cells than the rest — or again in the formation of the *macula acustica* in the otocysts of Heteropods and Vertebrates; glands often arise in this way, first a pit is formed, as in the peptic and mucous glands of vertebrate stomachs, and the little cluster of cells lining the bottom of the pit are differentiated into the gland cells.

The instances in which isolated cells are differentiated into distinct forms are much rarer, but are nevertheless often important. Thus the lasso-cells of the Coelenterata are scattered singly, but show a tendency to form limited groups. The numerous unicellular glands should be mentioned here, and also the scale-cells of Lepidoptera and the hair-cells of Orthoptera[1]. The most important and frequent case, since it is apparently common to all the Metazoa, is the method of forming the egg, by the modification of a single epithelial cell.

On the other hand there are cases in which the differentiation of the isolated cells, which earlier authors have described, has been denied by more recent investigators. Thus it had been affirmed that the hair cells were scattered singly in the epithelium of the olfactory region, and of the auditory ampullae of vertebrates, but Exner as regards the first organ and Kuhn as regards the second have affirmed that the modification known as the hair cells affects clusters, *i. e.*, the sensory area as a whole, not scattered cells. However this may be, it is not of great importance for us to know in connection with the present subject, for it is unquestionable that both forms of differentiation actually occur, and whether in a special instance one or the other mode obtains is a secondary problem.

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[1] It is probably not generally known that each scale on the wings of moths is, according to the interesting observations of Semper, merely an outgrowth from a single isolated cell. I have reasons for thinking that each of the minute hairs, which surmount the pores of the cuticula in the grasshoppers, is the product of a single cell.

I regard it as probable that the alterations in the size, shape, and position of the nucleus, which is at first spherical in form and central in position — that these alterations also proceed according to fixed laws, but I have obtained no satisfactory results.

6. *The primitive cells of the mesoderm are amoeboid in character.* For all mesodermic cells, not mechanically united to other cells, but capable of independent locomotion by amoeboid movements, I propose the collective name of *mesamoeboids* — as a term at once appropriate and corresponding to a natural class of tissues. The mesamoeboids then I regard as the primitive form of the cells of the mesoderm, thus implying that when amoeboid cells are found in the higher Metazoa, we are dealing with those mesodermic elements which have been least modified in the course of development. According to this view the wander cells and white corpuscles in vertebrates represent the earliest condition of the mesoderm. To prove this thesis it must be demonstrated (1) that in the lowest Metazoa the cells of the middle layer are mainly amoeboid in form, and (2) that the mesoderm is formed in the young embryo of the Metazoa as a collection of amoeboid cells. Both these demonstrations can, I think, be partially made by reference to observations already published. I have myself made observations which confirm my views, and indeed, it was while examining a specimen of Grantia that the importance of "mesamoeboids" first struck me.

A. That the middle layer of the sponges consists mainly of amoeboids cells is now a familiar fact, thanks to the brilliant investigations of F. E. Schulze and others, and it is not difficult to confirm these observations. Schulze has shown that it is even from these cells that the sexual products arise. It has, however, not yet been shown that this layer is strictly homologous with the mesoderm.

In the case of the Coelenterata, the mesoderm is formed from several sources, and includes : (1) the reproductive cells, (2) the muscular fibrillae, (3) gelatinous tissue, the cells of which are amoeboid in character. In these animals the histological differentiation of the spermatozoa, ova, and muscles precedes their separation from the ectoderm — and only a portion of the mesodermic elements exist in or pass through the mesamoeboid stage. We must therefore be cautious in attributing importance to the primary value of these cells.

B. In the embryo of all metazoa higher than the Coelenterata, amoeboid cells are often the first mesodermic elements to appear.

As regards the echinoderms I refer to Selenka[1] and Götte[2], who describe with unquestionable clearness the development of the mesoderm out of the amoeboid cells, of which it is at first solely composed. Upon worms but few investigations concerning the origin of the mesoderm have been made; in Phascolosoma Salenka[3] states that "*Blutzellen*" arise from the entoderm, and entering into the cavity between the two primitive layers, these represent the first cells of the mesoderm; there cannot be much doubt that these so-called "*Blutzellen*" are the primitive mesamoeboids. In other forms no mesamoeboids have been described — for example in the Nemertines Barrois[4] traces the mesoderm to epithelial discs, belonging to the original ectoderm, but his observations seem to me by no means satisfactory upon this point, and when he describes the delamination of the blastula in Amphiporus (*l.c.*, p. 146 of the reprint) as resulting in the formation of the ectoderm and mesoderm, at a time when the entoderm does not yet exist, he assumes a method of formation of the germinal layers without parallel or analogy — for the portion which he designates as mesoderm corresponds in position and histological structure to what has been found to be the undoubted entoderm in other animals. The same difficulties of incompleteness renders it impossible to decide the problem in hand by reference to other investigations — though Bütschli[5] mentions no amoeboid cells in Cucullanus, but on the contrary figures the mesoderm in its earliest stage as an epithelial plate.

In the case of several invertebrates there are said to be two large cells filled with yolk granules, and serving as the origin of the mesoderm. These instances are Lumbricus[6], Unio[7], Pedicellina[8], and

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[1] Selenka. Zur Entwickelung der Holothurien. Zeitschr. f. wiss. Zool., XXVII, 156. Taf. XI, figs. 19–21.

[2] Götte. Vergleichende Entwickelungsgeschichte der Comatula mediterranea. Arch. f. Mikr. Anat., XII, (1876), p. 587. Taf. XXV, figs. 1–5.

[3] Zeitschr. wiss. Zool., XXV, 442.

[4] J. Barrois. Mémoire sur l'embryologie des Nemertes. Am. Sci. Nat., Zool., S. VI, T. VI, (1877).

[5] Bütschli. Zur Entwickelungsgeschichte des Cucullanus elegans. Zeitschr. wiss. Zool., XXVI, (1875), p. 104.

[6] Kowalvseky. Embryologische Studien an Würmer und Arthropoden. Mém. Acad. St. Pétersb., XVI, (1871).

[7] Rabl. Ueber die Entwickelungsgeschichte der Malermuschel. Jena. Zeitsbhr., X, 347.

Clepsine[1]. In other animals the entoderm forms lateral diverticula (*e.g.*, Sagitta, tunicates, brachiopods and Amphioxus), which are likewise said to be concerned in the formation of the mesoderm, — but whether these diverticula do really form the mesodermic tissues properly so-called is doubtful. In both modes of development, as well as in other cases, we still find the mesoderm to consist at an early stage either exclusively or in part of mesamoeboids. I will refer to Bobretzky's observations on gasteropods[2], Bütschli on Paludina[3], Kowalewski on Pyrosoma[4], Reichenbach on the cray fish[5], Stecker on Calyptræa[6]. It were easy to add to these references.

It has long been known that the cells of the mesoderm in vertebrates are usually plainly amoeboid, and several authors have seen their amoeboid movements.

From this brief discussion it is evident that the two points necessary to establish our thesis cannot be certainly proved with our present knowledge — while on the other hand the view advanced of the primary importance of the amoeboid cells of the mesoderm is quite plausible. If its correctness can be demonstrated it will be interesting to have discovered it, because we shall then have determined primary *histological* differences between the three germinal layers in their earliest stages, as follows: —

Epithelial.
- A. Small cells, mainly protoplasmatic. . . . . *Ectoderm.*
- B. Large cells, with much dentoplasm. . . . . *Entoderm.*

Amoeboid.
- C. Cells free in the cavity between the two primitive layers, ecto- and entoderm. . . . . *Mesoderm.*

In publishing these preliminary remarks I wish to add that I intend them only as forerunners of a larger work upon which I am engaged, and in which I hope to discuss these questions at greater length.

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[1] Whitman. Embryology of Clepsine. Quart. Journ. Micr. Soc., Lond., XVIII, (1877), p. 82–86 of the reprint.

[2] Bobretsky. Studien ueber die embryonale Entwickelung der Gasteropoden. Arch. f. Mikr. Anat., XIII, 95, figs. 48, 77, 79, etc.

[3] Bütschli. Zeitschr. wiss. Zool., XXIX, 219, and XXVII, 519.

[4] Kowalewski. Arch. f. Mikr. Anat., XI, Taf. XXXIX.

[5] Reichenbach, Zeitschr. wiss. Zool., XXIX, 123.

[6] Stecker. Morph. Jahrb., II, 536.

THE KAMES AND MORAINES OF NEW ENGLAND.

BY GEORGE FREDERICK WRIGHT.

In December, 1876, I read a paper before this Society on "Some Remarkable Gravel Ridges in the Merrimack Valley," an abstract of which was published with maps, in Vol. XIX. p. 47–63 of its Proceedings. A year previous, a paper of similar import was read before the Essex Institute, an abstract of which may be found in Vol. VII, 165–168, of their Bulletin.

The phenomena described in those papers, prove to be even more extensive than we then anticipated. The two persons to whom science will be most indebted for observations in the field concerning the topic under consideration, are Mr. Warren Upham, of the New Hampshire Geological Survey, and Prof. George H. Stone, of Kent's Hill, Maine. I propose, this evening, to give their observations with my own, that the whole subject, so far as now known, — both in its phenomenal and theoretical aspects, — may be before us.

For detailed descriptions of the gravel ridges described, you are referred to my previous paper, and to the third volume of the New Hampshire Geological Report, prepared by Mr. Upham.

The completed results of Professor Stone's observations in Maine will not appear in authentic form till another year has been spent in the field. For facts regarding the series of ridges in Maine, I am indebted to articles by him in the Maine Farmer, the Lewiston Evening Journal, and to private correspondence.

1. In Sweden the chief phenomena under consideration are called "Eskers," in Scotland "Kames," which is the word adopted by Mr. Upham, and may well come into general use.

A kame, as we now know it, is a single ridge of gravel, (or series of tortuous and reticulated gravel ridges, occupying a belt sometimes a quarter of a mile wide, and from twenty to a hundred feet in height,) extending to indefinite distances in linear direction. The base of the cross section of a single ridge is usually not more than four times the height, — the slant being about as steep as the nature of the material will permit in the open air.

2. They are composed of rounded or irregular stones, gravel, sand and clay. The stones are frequently three or four feet in diameter. The extent to which they are rounded varies greatly in different localities.

There is, also, the greatest diversity as to stratification. In some localities the ridges are largely of sand and gravel, and uniformly with an anticlinal stratification. In other places there is no stratification at all, large stones resting in sand, clay and gravel, in all positions and at all heights. Frequently, for long distances, one can walk upon the large stones lining the top of the ridge.

3. Kames occur at all heights above the sea. In this vicinity they come down to the sea level. In the Penobscot valley, above Bangor, Maine, the sea has covered them since their deposition. Fossiliferous marine clays (Leda clays) of the Champlain period, there flank their sides, and sometimes completely cover them. In that region, also, as elsewhere, large angular boulders, which have evidently been transported on ice flows, are thickly strewn over ridges of fine gravel covered with clay. In the Penobscot valley, as elsewhere, the boulders are most thickly strewn upon the northern slopes.

But kames are not confined to low levels. They rise into the interior of Maine and New Hampshire, and are found 1,400 or more feet above the level of the sea. The series running south-west from the Rangeley Lakes is at this height, as are also those in the vicinity of the Fabyan House at the foot of Mt. Washington (1,570 ft.). Those at Colebrook, N. H., are upwards of a thousand feet above the sea level.

4. Parallel systems of kames occur at tolerably regular intervals, from the Connecticut river to the Province of New Brunswick, their general course being from north-west to south-east, corresponding nearly to the direction of the striae upon the rocks, and, to a considerable extent, independent of the present water courses. I append a provisional list of the systems, as far as now known.

No. I begins in No. 9, 4th range, Aroostook Co., Maine, runs S. E. to Houlton, thence more southerly, through Grand Schoodic Lake, and across the bend below, to Little Falls and the St. Croix River, a distance of 90 miles. A branch from New Limerick joins this at Amity.

No. II begins, so far as known, in Hersey, about twenty-five miles west of Houlton, follows down the valley of the Mattawamkeag through Haynesville, Bancroft, and Danforth, to near Tomah Station, down the Tomah, across the Schoodic, into Baileyville, and so on to Meddybemps, Denneyville and beyond, nearly opposite Grand Menan ; about 120 miles.

No. III, the next series westward, is less perfectly made out. But a long kame is described in the State Geological Report in the Seboois Lake region, on the head of the East Branch of the Penobscot. A system is reported from Crystal, down the Molunkus river, crossing the Mattawamkeag in Kingman, it passes through Webster to Springfield. Farther south they are reported, west of Sisladobsis Lake, and in the upper valley of the Machias River, in townships Nos. 43, 37 and 31. 120 miles.

No. IV. About ten miles farther west, kames appear from Stacyville south, down the Salmon River, at the mouth of the Mattakeunk, across from Mattawamkeag, and up the stream to Lee, and still farther south in township No. 3, and along the whole line of Nickatouas Lake, to the headwaters of the Narraguagus, still farther south to Beddington and the great Deblois plains. 90 miles. The connection between the segments of these last two series is not every where demonstrated.

No. V begins south-east of Mt. Katahdin, crosses Millinoket Lake obliquely, near its foot, runs down the west branch of the Penobscot, near the foot of Grand Falls; crosses the valley of the Nollesemick, thence through a low pass down the Madunkeunk, and through Chester to Hockamock Island, where it crosses the Penobscot. Thence it goes south and east, through Enfield, Passadunkeag, Greenbush, Greenfield, No. 32, Aurora (here known as the Whale's Back), and so on through No. 22, to the great Deblois-Cherryfield-Columbia plains, 120 miles. Series Nos. IV and V join in the Deblois plains.

No. VI is reported from the Twin Lakes, on the west branch of the Penobscot, about ten miles west from the Katahdin series. It crosses a low divide into the valley of the Seboois stream, runs east of Endless Pond, southward through Maxfield, Howland, Edinburg and Argyle, where it crosses the Penobscot at Olaman Island, thence south-easterly to Greenfield, where it is said to join the main Katahdin series.

No. VII is reported as beginning near Lake Seboois in the east part of Piscataquis Co., and running south through Medford, La Grange, Alton, Old Town, Orono and Veazie. It is quite obscured for two or three miles above Bangor, but shows plainly below as a series of high ridges as far as Hampden Upper Corner. High Head, a little below Bangor, is a part of this system. This series is but a few miles from the preceding, and very closely parallel. It makes a remarkable bend to the westward above Bangor, corresponding to the present course of the Penobscot River.

No. VIII is somewhat conjectural, but kames are reported at the south-east of Moosehead Lake in Greenville, in Abbot, Sangerville, Dover, Garland, Charleston, Cornish, Kenduskeag, to near Levant, then, with some interruption, through Carmel, to Herman Pond; thence through West Hampden, into Winterport, where it runs into the Penobscot River near Ball Hill cove. 80 miles. These are the kames described by Prof. Agassiz in the Atlantic Monthly. A short series which we will not number, runs from Dexter south through Corinna, East Newport, Plymouth, to Dixmont Centre.

No. IX hypothetically begins with ridges reported in No. II, 3d Range and Blanchard, and others reported south, in Mayfield and Brighton, and others from the east end of Moose Pond, through Hartland, Palmyra, Pittsfield, Burnham and Unity, where there are extensive sand plains. But the kame emerges from the south side of them, and runs along the Half Moon stream, into Knox, and probably through Montville, and down the St. George River, a short series from the west end of Moon Pond. I omit a conjectural line along the Kennebec, through Carratunk, Bingham and Fairfield, as also anôther conjectural line through from Dead River, Mercer, Belgrade and Sidney, where a great sandy plain corresponds to that of Deblois, north-east of Mt. Desert.

No. X may be called the Saddleback series, beginning in the lee of Saddleback mountain, as the Katahdin series does in the lee of Mt. Katahdin. This is mostly swept away in the upper portion of Sandy river, but the kames appear in Chesterville and as plains through Fayette, Wayne, and Leeds; and in the lower part of the course and a few miles west, and the other side of the Androscoggin, there is a parallel series from Wilton through Livermore, Turner, and to Auburn, just above Lewiston.

No. XI, Rangeley Lake series, is reported by Rev. W. E. C. Wright as passing through Lake Welakennebacook, thence down Black brook and Ellis river through Rumford across the Androscoggin, then up Baker's brook through a narrow pass in Woodstock to Bryant's pond, thence, according to Professor Stone, down the Little Androscoggin through Paris and Oxford to the sandy plains in Poland, about 80 miles.

No. XII appears in Fryeburgh near the New Hampshire line, and follows the Saco valley as far as Buxton, a few miles above Biddeford. This series is spoken of as consisting largely of plains.

No. XIII is traced from Conway, in N. H., to Ossipee lake, thence along Pine river, and past Pine River pond and Balch pond into Acton, Me., thence south-easterly through Sanford, North Berwick, and into Wells.

No. XIV appears, perhaps, in Thornton, in the Pemmigewasset valley, and again at Meredith and Wiers and in Guilford, along the south-west shore of Lake Winnepiseogee, through Alton and into New Durham, and on through Farmington and Rochester to Dover and Portsmouth.

No. XV is shorter, running from Epping through Fremont, Kingston, South Newton, South Hampton, Amesbury, Mass., to Newburyport.

I regard No. XVI as beginning in Candia, passing through Chester, Sandown, East Hamstead, Plaistow, N. H., and Haverhill, Groveland, Georgetown, Boxford, Topsfield, Wenham, and Beverly, Mass. This is the Haverhill series described in my previous paper.

No. XVII perhaps begins in Franklin, N. H., and appears below again in Sanbornton, Boscawen, and Concord, thence down the Merrimack river to Manchester, thence through the north part of Londonderry, and Derry, with some interruption, to Salem, N. H., thence through Methuen, Mass., Lawrence, Andover, Wilmington, Reading, Wakefield, Melrose, to Malden. This is the Andover series, as described in my previous paper.

No. XVIII is shorter and somewhat more indistinct. But it is tolerably clear, beginning at West Windham Station, in N. H., thence south-east through Pelham, Dracut, in Mass., crossing the Merrimack three miles below Lowell, thence through Tewksbury, and probably through Burlington and Winchester; the line would naturally strike the remarkable kames in Kingston and those running through Plymouth to Sandwich.

Between this and the preceding series another intervenes for a few miles. South-east of Haggit's pond in Andover is an extensive sand plain. Coming out of this in Tewksbury, just east of the State almshouse, is a well-defined kame, which continues four or five miles south-east into Wilmington, crossing the Shawshin river at an acute angle above Burt's mills. This disappears in sandy plains to the south. In Woburn and Winchester kame-like deposits appear in the valley at various intervals. At a point about two miles above Winchester village appears what is strikingly like a portion of a terminal moraine.

No. XIX we may for the present begin below Nashua, N. H., passing through Tyngsboro', Mass., Chelmsford, Billerica, Bedford, Lexington, Waltham, Newton, Dedham, Norwood, Canton, and thence southward to the Taunton river. This information is furnished, in Chelmsford by Mr. Butterfield, and in Newton by Rev. Mr. Slocum, who has mapped them for me, and for the rest of the course by Rev. A. E. Winship. He speaks, however, of a series more to the east, which perhaps is the continuation of this, passing through Holbrook, west part of Abington, east part of Brockton and Bridgewater, and through Middleboro.[1]

No. XX. This I begin for the present in Groton (east part) through Boxboro, Littleton, Framingham (?), Foxboro, Mansfield. Who knows the towns intervening?

(Kames are crossed by the Fitchburg R. R. in Littleton near Sandy pond, Ayer Junction near Mossy pond, Shirley, East Fitchburg, near Ashburnham depot. In Winchendon, for some distance, the Cheshire R. R., follows a kame towards Fitzwilliam, N. H.)

No. XXI. Mendon, Blackstone, and on towards Providence, R. I.

No. XXII. Passing into the Connecticut valley, I am anxious to know more about the kames appearing in Peterboro, N. H., and running south through Rindge, Ashburnham, West Fitchburg, and Winchendon.

(Two miles north-west of Keene, N. H., the railroad passes through a fine development of kames.)

No. XXIII. We mention also, as the last of which we have information, the Connecticut river kame proper, extending, with various interruptions, from Colebrook, N. H., to the Massachusetts line.

(The Rutland R. R. crosses a well-developed kame, one mile north of Ludlow, Vt. This is near the summit of the range, and the ridges of gravel descend from high lands into the valley above the village, and cross it at an acute angle.)

---

[1] Trustworthy facts are accumulating slowly respecting this series. From Hudson, east of the Merrimack, a well-defined kame extends to the river near the iron bridge in Tyngsboro. On its way it passes through Tyng's pond, causing a line of shoals through the centre, between the abutments of the ridge which descends to the water from high grounds to the north, and rises out of it by the log-cabin on the south. The river road (on the north side) to Lowell crosses two other kames nearer the city; one of which (near the Pawtucket bridge) is now being rapidly removed for its gravel. This, most likely, connects itself with gravel ridges coming down through Pelham in the valley of Golden brook. On the south side of the river, near the Poor farm in Lowell, and two miles west in Chelmsford, and farther south and west in Westford, kames are well marked.

5. In connection with the paper published by me in the Proceedings two years ago, Mr. Clarence King surmised that a terminal moraine appeared at Falmouth, Wood's Holl, and in the Elizabeth Islands, west of Martha's Vineyard. (See p. 62, Dec. 20, 1876.) Mr. Upham's investigations have since placed this beyond question. The conclusions to which he comes are partly published in the third volume of the New Hampshire Report, but the later investigations are yet to appear.

The results, briefly stated, are that a distinct terminal moraine can be traced from the hills south-east of Town Cove, at Orleans village, through Brewster Station, West Brewster village, in the north-western part of Dennis, through the centre of Yarmouth, a mile south-west of Yarmouthport, Barnstable village, and West Barnstable, from one to three miles south of Sandwich village, West Sandwich, and North Sandwich. There it forms a right angle, passing from one to three miles east of Monument village and Poccasset, through North Falmouth, West Falmouth, and Wood's Holl. The Elizabeth Islands are nothing else than the back of the moraine emerging above the water. At West Brewster and from Follen's pond, two miles west of German's hill, in Yarmouth, as through Falmouth and the Elizabeth Islands, the material is very coarse. In Sandwich, the hills, 200 to 300 feet high, are of modified drift with few boulders. (A tongue of the glacier from the Merrimack valley seems to have pushed down across Massachusetts Bay to the Cape, such as pushed out from Lake Erie up the Maumee river, and in Wisconsin up Green Bay. The Andover series of kames prolonged would strike Plymouth.) This line of moraine is, according to Mr. Upham, represented along the south shore of Rhode Island, from near Point Judith to Watch Hill, in Fisher's and Plum Islands, and along the north shore of Long Island, as far west as to Port Jefferson.

According to Mr. Upham the continuous terminal moraine appears first in Sankaty Head and Saul's Hills in Nantucket, on Tuckernuck Island, Chappaquiddick Island, and Vineyard Haven on Martha's Vineyard, in the prominent hills south-west to Gay Head, reappearing again in No Man's Land, and Block Island, which is a remarkable knot of hills. On Long Island it appears at Montauk Point, thence to Sag Harbor and Canoe place, thence due west, to Harbor Hill at

Rozlyn, the highest point in the island, thence west south-west, through Greenwood Cemetery, Brooklyn, to the Narrows at Fort Hamilton, and across the south-east part of Staten Island. Prof. Cook, of New Jersey, has accurately marked its line across that State, in his report for 1878. Beginning at Perth Amboy, it bends northward, through Raritan, Plainfield, Chatham, Morris, and Hanover, to Rockaway, thence a little south of west, to Oxford, on the Delaware River, a few miles above Easton.

6. These terminal moraines resemble, in many respects, what would occur if a line of such hills as appear in Boston Harbor were closely clustered together, and extended the whole distance mentioned. Their summits, however, are not so symmetrical as those of the so-called lenticular hills. The width of this terminal belt of hills is from one to two miles. In this belt there are immense enclosed basins, called in Wisconsin kettle holes. They are frequently much larger than similar enclosures in the kames. I noticed one between Falmouth and Wood's Holl, that must be a quarter of a mile in diameter, and two hundred feet deep. Mr. Geo. W. W. Dove and I agreed that the tendency of this moraine belt, on the island of Naushon, was to break up into alternate long hollows and ridges nearly at right angles to the main line. Mr. Upham also has observed something like this in Wellfleet and Truro. Nearly everywhere where I have observed it, the moraine is covered with large, angular boulders, frequently of immense size. Near the Quisset House, between Wood's Holl and Falmouth, I found the boulders beneath the surface distinctly striated. In general the composition is something like that of the lenticular hills, though not so largely composed of compact clay.

I have been trying to make out that the lenticular hills of the latitude of Boston were arranged with some reference to that southern terminal moraine, but with indifferent success. Still there is an approach to continuity from Pigeon Hill on Cape Ann, and a singular hill of clear boulders between Rockport and Gloucester, through Ipswich, Rowley, Topsfield, Danvers, Peabody, Chelsea, Boston and Brighton. (The lenticular hills in Grafton and Spencer are in the same latitude.) Then after a belt of five or six miles where they are conspicuous for their absence, there is tolerable continuity again from Stratham, seven miles west of Portsmouth, N. H., through Salisbury, Amesbury, Greenland, Bradford, North Andover, Andover to Lowell, Mass.; and to an unknown distance south-west. Similar hills are abundant in West Acton, Ayer Junction, Leominster, Lunenburg, and West Fitchburg. Whether these clusters of lenticular hills may be correlated with similar clusters farther west in Hillsboro' and Cheshire counties, N. H., I will not venture to say. But those clusters are in the same latitude, and may not unnaturally mark periods when the ice sheet paused, before its final advancement to the south shore.

7. We wish now to return to some of the peculiarities of the kames. As we have seen, they run, in the main, at right angles to the terminal moraine. They are frequently, but not always, stratified. The stones in them are never striated; are usually worn smooth, but frequently are only slightly smoothed. The twenty or more series of kames, to which I have called your attention, preserve their even way with remarkable regularity, being nearly parallel with one another for scores of miles. They cross rivers and valleys, and elevations under two hundred feet, without difficulty. They frequently overlie the lenticular hills. They are never deposited in channels worn in the till. I must make more particular mention of the independent manner in which the kames treat minor irregularities.

Professor Stone relates that in Plymouth, Penobscot Co., Maine, the kame crosses Newport Point, and the level country south, partially climbs the hill north of Plymouth, begins again on the south slope, crosses Plymouth pond, climbs another hill (almost disappearing at the top) then descends to North Dixmont, and continues some distance as a ridge seventy feet high, then expands into a plain, beginning again as a series of ridges and hillocks, ending in the great Dixmont range. The noticeable thing in Plymouth is that a conical hill seems to deflect the kame slightly to the east, keeping it up on hills one hundred or more feet above the neighboring valley.

The Rangeley Lake kame, as we have seen, follows down a tributary to the Androscoggin, on one side, and follows it up on the other, and crosses the water shed into a more southerly portion of the valley.

Mr. Upham records, that in the Ossipee basin the kame rises from the mouth of Pine river, to the water shed between that and Balch Pond fully 150 feet (N. H. Geol. Rep., III, 148). In my previous paper several instances are mentioned of kames passing over lenticular hills, and down into comparatively narrow valleys, as at Lawrence. I will only add two other instructive examples of a different sort.

Between Rowley and Georgetown the road passes north of Hunslow's hill. A spur of the Haverhill series of kames was thought to start a little south-west of this hill. But north of the hill, and some distance to the east of this spur, a kame approaches the hill, and stops short at its foot, the hill rising immediately south of it one hundred or more feet.

Again, in series No. XVIII, three miles below Lowell, the kame descends the valley from the north, to the Merrimack river. On the south side of the river, it appears in the bank, but completely covered with a deposit of levelly stratified loam, which is much above the present high water level. For some distance in the stream, at low water, the ridge can be seen under the surface, on the south side of the river. A quarter of a mile south of the bank, the kame emerges from the loam, and ascends a steep hill. Half-way up, it turns a right angle, and in about ten rods, another right angle, and goes on its way to the highlands beyond. It does not ascend over two hundred feet above the river, however, before it descends again. These facts, and the frequent unstratified character of the material, make it apparent that the material forming the kames has, in many places, settled down in the irregular manner described by Clarence King, from ice which was at least two hundred feet thick. In no other way could the kame so accommodate itself to the original contour of the land. This is confirmed by a section exposed in Andover, Mass., last fall. The kame near the red spring showed thirty or forty feet entirely without stratification, except that about one-third of the way from the bed, a reddish line (showing more oxidation of the iron than elsewhere), appeared clear across the section.

One objection to supposing the material to have settled down in this way, is that frequently it is so local in character that it is not easy to see how it could first get on the back of the ice sheet.

But there is usually in the kame, much mingling of local with foreign material, and on any hypothesis it is difficult to account for the raising of pebbles to the height of the top of the kames. We should notice that the movement of a glacier over the surface of the rocks is somewhat analagous to that of a jack-plane over a board, and as the shavings rise above the top of the carpenter's plane, so as a resultant of the onward motions and the friction, stones may work up in the ice. Or it might be compared to the shaking of stones in a basket, in which the larger would rise to the top.

I do not question, that in many cases, especially where the stratification is marked, the kames have been deposited by running water, as Mr. Upham thinks, in channels worn in the ice by the streams which gorged every outlet in the last days of the ice period. But it still seems to me important to insist, that another movement such as was pointed out by Mr. King, is also frequently demanded to account for all the phenomena.

8. So, if the existence of earthy material in definite lines on the surface of the ice, without regard to how it was brought into line there, be enough to constitute a medial moraine, the kames are true moraines. That is, the earthy material, held in the upper portions of the glacier, existed in excessive amount in the line of motion from the high mountains, and was swept by superficial currents, into lines upon the top of the ice, where, at the last stage, it would frequently be so thick as to preserve vast bodies of ice underneath from melting. From these masses the earth would slide down irregularly, forming the unstratified and reticulated ridges so frequent and so regularly recurring in New England.

This view is confirmed by the frequent sub-angular character of the material, and by a fact noticed by Prof. Stone, that the nearer we come to the White Hills, the vaster became the classified deposits — the pebbles being then two, three, and four feet in diameter.

Mr. Upham mentions, also, that below Concord, N. H., the pebbles in the kame, are one foot in diameter, and abundant, while many are two and three feet, and that all sizes are indiscriminately mixed through the whole mass. He also speaks of sections of the Merrimack kame about Hooksett, as consisting mainly of numerous rock fragments up to four or five feet in size, with no evidence of water action.

Glacial Drift in Boston and its Vicinity.

By Warren Upham.

When Winthrop and his company came to Boston, ten years after the landing of the Mayflower at Plymouth, they found a much more fertile soil and more majestic forests than those which had seemed goodly to the Pilgrims because with them they had found liberty. The cause of this difference is geological. Rivers which flowed down from the surface of the great ice sheet at its melting, spread comparatively barren gravel and sand, often in the irregular hillocks and ridges called kames, and elsewhere in extensive level plains, over the greater part of Plymouth and the entire region occupied by the Old Colony, including the peninsula of Cape Cod; while in the vicinity of Boston only small areas of these deposits are found, and the region consists mainly of till, or unmodified drift, accumulated by the ice alone, without being transported and stratified by currents of water. The till therefore contains all the ingredients that existed in the beds of loose material which had been produced by long-continued decomposition of the rocks or gathered by previous glacial action, and which, with much detritus eroded from the solid ledges, were ploughed up and thoroughly kneaded together by this ice-sheet, carried southward in and beneath it, and amassed in flattened sheets or in steep and high, ovally rounded hills, which are finely exhibited in Boston and within a circuit of five to fifteen miles upon all sides of this city.

Before considering these accumulations of till, it will be well to inquire briefly what the ice-sheet was. This we may learn in part from the Antarctic continent, which is now similarly covered by ice that extends far out to sea, and, because it is lifted up by the ocean and broken into bergs, terminates in a vertical wall, along which Sir J. C. Ross sailed four hundred and fifty miles; finding only one point sufficiently low to allow its upper surface to be seen from the masthead. Here it was a plain of snowy whiteness, reaching as far as the eye could see. East of Nantucket and Cape Cod, the margin of our ice-sheet was probably in such cliffs, extending a thousand miles to the east-north-east, along the line where we now have the remarkable submarine plateaus known as the fishing banks. The interior of Greenland is also covered at the present time by an ice-sheet, which rises steeply at its edge but soon changes to a gently sloping plateau, elevated above the highest peaks of the land upon which it lies. Dr. Hayes found the angle of ascent upon this plain to diminish from six to two degrees in thirty miles, at which distance he reached an altitude of about five thousand feet. The striated summits of the highest mountains of New England and New York show that the glacial sheet was at least a mile thick at a distance of two hundred miles north from its edge. Its greatest depth was much farther to the north, in fact beyond that part of British America which has been explored in respect to surface geology, and from this deepest portion it was pushed outward by the pressure of its own weight. Striae, or scratches and furrows on the bed-rock, show that it moved without much deviation straight forward over valleys, highlands, and groups of mountains. Boulders and detritus were thus gathered into the ice-mass, which became more or less filled with the materials of the drift, at least to the height of the ridges and peaks which it crossed. The worn surface of the ledges also shows that many boulders and pebbles were rolled and dragged along at the bottom of the ice-sheet, breaking up and grinding themselves and the underlying rock into gravel, sand, and even the finest clay.

At the end of the glacial period, the material which had been thus gathered, mingled, and swept along by the moving ice, was left in three different classes of deposits, namely, modified drift, upper till, and lower till. Under a warmer climate, melting and evaporation finally triumphed, so that there was no longer an annual excess of snow-fall which they could not remove. The glacial sheet then ceased to increase in depth, and its previously nearly level surface became hollowed with basins of drainage and channelled by rivers. The materials contained in the ice had been exposed near its termination to the washing of many rills and small streams through every summer; but when its decline and departure came, this melting was extended over a very wide area, and immense floods laden with clay, sand, and gravel flowed from the surface of the retreating ice-fields. In the lower part of the channels of these rivers, while they were still walled on both sides by ice, the heaviest portion of their burden, that is, the coarsest gravel and occasional layers of sand, were deposited, and when the ice-walls disappeared these remained as gravel ridges or kames. Oftener, however, the conditions favorable for the formation of these did not exist, and the whole load of the glacial floods was borne forward beyond the ice-margin and there spread in nearly level plains, especially along the valleys of rivers that flow southward, which appear to have been thus filled to the level of their highest terraces.

This modified drift lies above the other two glacial formations, which are generally classed together under the common name of unmodified drift or till. A large portion of the material held in the ice-sheet, including multitudes of large and small angular boulders, escaped transportation by its streams, and were dropped loosely upon the surface. This deposit is usually from one to five feet thick, but sometimes is found ten or even twenty feet in depth. Its characteristics are comparative looseness of its mass; its gravelly and sandy detritus, which has a yellowish color owing to the exposure of its iron to oxidation; and the abundance, large size, and prevailing rough and angular form of its boulders, which are often from five to ten and sometimes twenty or thirty feet in diameter. This formation, called upper till, covers the surface of New England generally, except where it is overlain by the modified drift, which was deposited slightly later by the floods discharged from the melting ice in its farther retreat northward.

The third and lowest division of the drift is called lower till, and appears to be a ground-moraine, accumulated beneath the moving ice-sheet. This deposit forms the principal mass of the hills alluded to as occurring in the vicinity of this city. It is distinguished by its very compact and hard structure; by its clayey detritus, which is usually dark colored and sometimes bluish, because of the imperfectly oxidized state of its iron; and by the planed sides of its boulders and pebbles, which are often marked with striae, and are generally not so numerous and large as in the upper till. Both these divisions of the till are entirely unstratified, boulders, pebbles, sand, and clay being indiscriminately mixed; but an obscure lamination in planes parallel to the surface is often noticeable in the lower till, especially where a section has been for a short time exposed to the weather. This was due probably to the mode of its accumulation, and seems to show that the ice, in its passage, added new material to the surface of its ground-moraine, which lay undisturbed below. The hardness of this deposit, which requires it to be loosened with a pick before it can be shovelled, appears to have resulted from the immense pressure of the ice.

In many portions of New England this lower till, or ground-moraine of the ice-sheet, is heaped in prominent hills, which are very abundant upon certain limited areas, extending ten to thirty miles and five to ten miles wide, while in adjoining districts of equal extent none of these accumulations are found. Their development in Boston, in neighboring towns, and in the islands of the harbor, is as typical and striking and as well adapted for a study of their character and origin, as in any region where they have been observed. Your attention has already been directed to this subject by papers which appear in the Proceedings of this Society, first by Professor Shaler in Vol. XIII, 196–203, and again by Professor Hitchcock in Vol. XIX, 63–67. The present essay gives a more detailed description than has previously been presented of these hills as exhibited in Boston and its vicinity, and will attempt to show the conditions and causes of their accumulation, so far as they seem to be discerned, pointing out also the problems connected with this and their remarkable distribution, which remain to be solved.

Examples of these drift hills, which are probably familiar to you all, are Beacon hill in Boston; Bunker hill in Charlestown; Breed's Island hill beyond East Boston; Green hill in Winthrop; Powder Horn hill in Chelsea; Mt. Revere; Mt. Washington in Everett; Tufts College hill; Winter hill and others in Somerville; Bigelow hill in Brighton; White's hill in Watertown; Owl hill in Waltham; Mt. Ida, Prospect, Institute and Oak hills in Newton; Corey's and Walnut hills in Brookline; Parker's hill in Roxbury; Bellevue and the Clarendon hills in West Roxbury; Brush hill in Milton; Jones' hill, Mt. Ida, and Pope's hill in Dorchester; Wollaston Heights, Forbes, President's, and Great hills in Quincy; Great and King Oak hills in Weymouth; Baker's, Otis, Prospect, and Turkey hills in Hingham; Scituate and Bear hills in Cohasset; Strawberry and Telegraph hills in Hull; and the hills of Deer Island in the harbor. These include only the most prominent examples found in this district, and after noticing the features that mark this class of hills, we have a very formidable descriptive list, with exactly determined or approximate heights, of these and more than a hundred others similar to them that occur within the same area.

These hills vary in size from a few hundred feet to a mile in length, with usually half to two-thirds as great width. Their height, corresponding to their area, varies from twenty-five to two hundred feet. But whatever may be their size and height, they are singularly alike in outline and form, usually having steep sides, with gently sloping rounded tops, and presenting a very smooth and regular contour. From this resemblance in shape to an elliptical convex lens, Professor Hitchcock has called them *lenticular hills*, to distinguish these deposits of till from its broadly flattened or undulating sheets, which are common throughout New England.

The trend, or direction of the longer axis of these lenticular hills is nearly the same for all of them comprised within any limited area, and is approximately like the course of the striae or glacial furrows marked upon neighboring ledges. In eastern Massachusetts and New Hampshire, within twenty-five miles of the coast, it is quite uniformly to the south-east or east-south-east. Farther inland, in both of these states, it is generally from north to south or a few degrees east of south; while in the valley of the Connecticut river it is frequently a little to the west of south. In New Hampshire, besides its accumulation in these hills, the till is frequently amassed in slopes of

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similar lenticular form. These have their position almost invariably upon either the south or north side of the ledgy hills against which they rest, showing a considerable deflection towards the south-east and north-west in the east part of the state. It cannot be doubted that the trend of the lenticular hills, and the direction taken by these slopes, have been determined by the glacial current, which produced the striae with which they are parallel.

The material of these hills may be well seen at many excavations for streets and other grading purposes near the city, as at the north-east part of Dorchester Heights in South Boston, at Powder Horn Hill, at Prospect Hill in Somerville, and at the west end of Parker Hill, as also in the sea-cliffs of Nantasket, Winthrop, and the islands of the harbor. These sections for grading vary from ten to fifty feet in depth, while the sea-cliffs near Point Allerton, and on Great Brewster, Lovell's, Gallop's, Deer, Long, Moon, and Spectacle islands, and at Winthrop Head and Grover's Cliff, rise fifty to one hundred feet in height. They are in all cases found to be composed of the deposit which we have described as lower till, sometimes showing the laminated structure, but nowhere, so far as I have observed, with any traces of stratification by currents of water. The covering of upper till on these hills is probably in most cases only a foot or two thick, and it is not so distinctly separated from the lower till as in most parts of New Hampshire and at Worcester in this state, where it is usually from one and a half to three feet thick, resting at a definite line upon the very hard and obscurely laminated, clayey lower till. The latter, with its dark gray color, presents a distinc contrast with the yellowish, gravelly and sandy, loose upper till, which shows no lamination, but is sometimes imperfectly stratified. In many of these accumulations near Boston, the upper ten to twenty feet are yellowish, gradually changing below to a dull gray color; but the whole bank is of nearly equal compactness, and contains abundant glaciated boulders and pebbles.

The earliest notice of any of our lenticular hills is found in Wood's "New England's Prospect," printed in London four years after the settlement of Boston, of which he says: —

"This *Necke of land* is not above foure miles in compasse, in forme almost square, having on the South-side at one corner, a great broad hill, whereon is planted a Fort, which can command any ship as shee sayles into any Harbour within the still Bay. On the North-side is another Hill equall in bignesse, whereon stands a Winde-mill. To the North-west is a high Mountaine with three little rising Hills on the top of it, wherefore it is called *Tramount.* From the top of this Mountaine a man may over-looke all the Ilands which lie before the Bay, and discry such ships as are upon the Sea-coast."

These elevations were Fort Hill, formerly about eighty feet high; but entirely removed between 1869 and 1873, so that its site is now only twenty-five feet above low tide; Copp's Hill, fifty-eight feet high; and Beacon Hill, which was originally about one hundred and thirty-eight feet high, but is now one hundred and five. These heights, with those which follow, are stated in feet above mean low tide.

Charlestown has two lenticular hills: Breed's, on which the Monument stands, 62; and the true Bunker Hill, a third of a mile north-west, 110.

In East Boston are Eagle Hill, 120: one a mile north-east from last, at east side of railroad, about 75; Breed's Island Hill, 165; and one a fourth of a mile southeast from last, about 50.

In Winthrop are Point Shirley Hill, about 60; Green Hill, terminating at the east in Winthrop Head, about 90; Grover's Cliff, about 60; one-fourth mile south-west, about 90; one-fourth mile farther south-west, about 75.

In Revere are Beachmont Hill, 119; Beach View Hill, three-fourths mile north-west from last, 134; Harris Hill, one-third mile north of last, about 75; Mt. Revere, 192; Mountain Avenue Hill, 173; Shurtleff Hill, one-half mile east of last, about 100.

In Chelsea are Government Hill, about 100; Bellingham Hill, about 110; and Powder Horn Hill, about 230.

In Everett are Mt. Washington, about 200; Woodlawn hill, about 160; and Belmont Hill, about 140; the last being a plateau of till, not distinctly lenticular.

In Medford is Walnut Hill, the site of Tufts College and the Mystic reservoir, 160.

In Somerville are Spring Hill, about 140; Winter Hill,145; Central Hill, 116; Prospect Hill formerly about 150, to be graded to about 120; Convent Hill, about 90; and Asylum Hill, 62.

The highest elevations of Cambridge appear to be made of the same material as the lenticular hills, but are too humble to be good types of this class. They are Washington Avenue Hill, 86; Reservoir Hill, 81; Observatory Hill, 80; Dana Hill, 62; highest part of East Cambridge, 55.

Lenticular hills in Watertown are Learned's, 126; White's, 192; and Payson's or Meeting House Hill, 236.

In Waltham most of the hills are ledge, but two, near the east edge of the township, namely, Mackerel Hill, about 250, and Owl Hill, about 225, appear to belong to this list.

In Brighton are Nevins Hill, 192; Bigelow Hill, 165; Brooks Hill, one-fourth mile east of last, 90; Brighton Hill, 140; Strong's Hill, one-fourth mile south-east from last, 175.

In Newton are Mt. Ida, 211; Nonantum Hill, 225; Prospect or Waban Hill, 317; Chestnut or Lee's Hill, 291; Institute Hill, 311; Oak Hill, 307; Bald Pate, 328.

In Brookline are Corey's Hill, 270; Aspinwall's Hill, next to the south, 250; Fisher Hill, or Mt. Vernon, north of Brookline reservoir, 260; Gardiner's Hill, south of the reservoir, about 225; Cabot Hill, about a mile west, 275; Mt. Walley, a mile and a half south of the reservoir, about 325; Walnut Hill, about 300; lower summit, about one-fourth mile west, about 270.

Ledges abound throughout Boston Highlands or Roxbury, and the only lenticular accumulation of till is Parker Hill, 235.

In West Roxbury are a hill one-fourth mile south-west of Jamaica pond, 231; one-fourth mile south from the last, 241; Slocum's Hill, next south, 285; one-third mile south from last, 306; one-third mile north from Roslindale station, 237; a little south of last, 190; close east of Arnold street, 237; Mt. Vernon street Hill, 220; one-half mile east from last, on north side of railroad, 252; one-third mile east from last, 275; Bellevue Hill, 341; one-half mile north, on Beach street, 210; the west Clarendon Hill, 227; the east Clarendon Hill, 245; Mt. Monterey, or Grew's Hill, partly in Hyde Park, 273.

In South Boston the principal summit of Dorchester Heights is 148; the north-east summit, originally about 130, is now being removed.

In Dorchester are Jones Hill, 139; Mt. Bowdoin, 165; Mt. Ida, 144; Pope's Hill, 125; hill close east of Ashmont station, 113; Wellington Hill, 186; and Codman and Capen's Hills, each about 125.

In Milton are Brush Hill, about 265, and Milton Hill, about 140.

In Quincy, the peninsula of Squantum has two lenticular hills, about 110 and 100; others are Wollaston Heights, two, about 75 and 125; Forbes Hill, one-fourth mile farther west, about 175; President's Hill, about 135; another, one-sixth mile west of last, about

150; Mt. Wollaston, a mile east from the Heights, about 75; Quincy Great Hill, about 100.

In Weymouth are Weymouth Great Hill, about 150; Rowe's Hill, about 100; and King Oak Hill, about 100.

In Hingham are Baker's Hill, about 175; Squirrel Hill, close north of last, about 150; Otis Hill, about 150; others at north-west and north, near Downer's Landing, about 75; Hingham Great Hill, a mile south-west from the Lower Plain, about 125; the northern hill of World's End, about 50; the southern, about 80; Planter's Hill, about 125; Turkey Hill, about 190; Prospect Hill, 243.

In Cohasset, are Scituate Hill, 180; at road, one-half mile south-east, about 125; Bear Hill, about 150; Walnut Hill, about 100.

On the peninsula of Hull are Sagamore Head, about 65; White Head, about 40; Strawberry Hill, about 75; one-sixth mile south-west from Point Allerton, about 100; Telegraph Hill, about 125; Thornbush Hill, west of the last, with the village of Hull intervening, about 110.

In the harbor the following are approximate heights of these hills forming its islands, as shown on a contoured map published by the United States Coast Survey: Great Brewster, 100; Peddock's island, comprising four lenticular hills, that most north-east being 70, the next 120, one-half mile south-west from these 60, and at the south-west end, 100; Bumkin island, 100; Prince's Head and Sheep islands, each about 30; Grape island, east hill, 60, west hill, 75; Raccoon island, 40; Nut island, 60; Moon island, 90; Moon Head, 25; Thompson's island, 50; Lovell's, George's, Gallop's, Rainsford, Governor's, Castle, and the two Spectacle islands, each about 75; Long island, in three hills, that at the north, 75, at the middle, 100, and at the southwest, 60; and Deer island, which also has three lenticular hills, at the south, 90, east of the hospital, 50, and at the north-east shore, 60.

It has been stated that the trend of these lenticular hills and the striation of the ledges are approximately parallel. In the area bounded by a line twenty miles inland from the coast, and thence reaching to the west side of the valley of the Connecticut river, the course of the striae and of the longer axis of these hills is nearly due south, varying from south-south-east to a few degrees west of south. Near the sea-board, however, we find both considerably deflected toward the east, and in this vicinity the trend of the lenticular hills is almost invariably south-east or east-south-east. In the western and southern portions of the district occupied by the hills here enumerated, it is nearly to the south-east; but Corey's, Parker and Beacon hills, and all those which occur north-east from Boston, in the harbor, and in Hull, trend nearly east-south-east, even bearing in some cases half way between this and due east. This elongation seems to have been produced by the motion of the ice-sheet, under which these accumulations appear to have been formed. Its parallelism to the striae shows that these masses assumed their oblong shape because in this form they opposed the least resistance to the glacial current.

There are good reasons for believing that the deflection in the trend of these lenticular hills was produced during the departure of the ice, which could hardly have its current thus deflected to the east-south-east at our sea-border throughout the whole glacial period. The southern limit of the North American ice-sheet coincided nearly with the course of the Columbia, Missouri and Ohio rivers. Across New Jersey, and on Long Island, Martha's Vineyard and Nantucket, it is marked by a definite terminal moraine. The line of continuation of this is over George's bank and the other fishing banks to the east-north-east. At this time, the motion of the ice-sheet, being directed toward its terminal line, was south, or between this and south-east over all New England. Next came a period of warmer climate, which drove back the ice-fields a considerable distance. This was followed by a cold epoch, when they again held their ground, and, probably after some reädvance, preserved a nearly unchanged boundary through a sufficiently long time to accumulate a second terminal moraine, by which we are enabled to mark the variable width of the area from which they had retreated. In Wisconsin we find this to have been three or four hundred miles; in Ohio, about one hundred miles; on Long Island, and thence to Martha's Vineyard, five to fifteen miles; and at Nantucket, thirty miles.

We are interested in this retreat of the ice-sheet in south-eastern Massachusetts, because it throws light upon the question when the lenticular hills of our district received their eastern trend. Between these epochs, in which terminal moraines were formed, the ice-front had withdrawn from the hills in the north-west part of Martha's Vineyard only five miles, to the chain of the Elizabeth Islands; but its retreat from Nantucket was thirty miles, to Brewster and Orleans on Cape Cod. At this time we must suppose that the ice-current all over eastern Massachusetts was still approximately to the south. The warmth of the ocean, however, had begun to melt away the ice-fields which encroached upon its depths more rapidly than they were driven back upon the land or in the shallow sounds south of New England. At their further departure it seems probable that this cause produced within the Gulf of Maine a great bay in the terminal front of the great ice-sheet, so that it was entirely melted away east of Massachusetts, while it yet remained in great depth upon all our territory except its southeast portion. The effect of this unequal rate of retreat would be to leave the ice upon our coast unsupported at its east side, and to cause its motion consequently to be deflected toward the vacant area. The lenticular hills were probably mainly accumulated before this time, having their trend in the nearly southward course in which the ice-sheet had hitherto moved. When this course was changed, it appears that these massive hills were turned partly around to conform to the ice·current. This was done, too, in a comparatively short time, for the ice sheet was wholly melted before it could efface much of the previous striation upon the ledges, which in this same district is generally between 10° and 30° to the east of south. In the north-east part of Essex county and near the coast in New Hampshire, the old glacial markings have been mostly erased by the deflected ice-current, and their prevailing course, like that of the hills of glacial drift, is about south-east.

The group of lenticular hills here described, has its boundary on the north-east, north, and north-west, at a distance of five miles from the State-house. In Watertown and Waltham this radius extends to eight miles, and continues about the same in the further circuit at the south-west and south, as far as to Quincy. Then it increases to fifteen miles, reaching to Prospect Hill in Hingham and to Bear and Walnut Hills in Cohasset. Eastward the most remote of these hills are at Point Allerton and the remnant of one on Great Brewster island, both less than ten miles distant. In all parts of this district, with the exception of Roxbury, lenticular hills are of frequent occurrence. Beyond Hingham and Cohasset, massive hills, composed principally of till, but not generally of the typical lenticular form, extend nearly ten miles farther, to Telegraph Hill in Marshfield. On all other sides this area is bounded by tracts entirely destitute of lenticular accumulations of till, and often having scarcely any covering upon the ledges, which are low and undulating or elevated in rugged and broken ranges of hills.

This kind of topography surrounds our districts of lenticular hills excepting oceanward. Its width at the north-east is fully ten miles, to Beverly, Danvers, and Middleton, in which another area of these smooth-topped, fertile drift-hills begins and thence extends twelve miles north-east through Wenham, Hamilton, Topsfield and Ipswich. The width of this group of lenticular hills is about eight miles, from the north-west part of Essex to Prospect and Hundslow hills in Rowley. These, with Oldtown hills in Newbury, and Bald Hill in Boxford, are the outposts of this group at the north-west. The narrow belt of nearly level land destitute of these accumulations, which lies next to the north-west, was first pointed out to me by Rev. G. F. Wright. Its width is about four miles, extending in a nearly straight line from the south-east corner of Andover to Newburyport; and it may be said to continue with about the same width along the coast through Salisbury and onward to Portsmouth, N. H., since this margin, excepting Boar's Head, has none of these accumulations of till. Next to the north-west there succeeds a very fine development of the lenticular hills, averaging nearly ten miles in width, and reaching from Andover, Lawrence, and Methuen fully twenty-five miles north-easterly to Stratham, N. H.

The distance to be crossed north-west, west, and south-west from the group of lenticular hills about Boston, to reach any similar development of them in the interior of the State has not been explored. The only statement that I can make is the negative one that I saw nothing of this kind in a journey from Lowell through Billerica, Bedford, Lexington, Waltham, West Newton, Needham, West Dedham, Norwood, Canton, Stoughton, Brockton, Abington, Rockland, Hanover, and Pembroke to Duxbury. They are known to be finely exhibited in the north-west part of Worcester; in Ayer and Groton; in the north-west part of Leominster; in Gardner; in Bernardston, Gill, and the north part of Montague; and in Amherst, South Hadley, and the west edge of Granby. Some of these localities are probably portions of quite extensive areas similar to the group of these hills about Boston, or to their two belts in Essex county. It is to be noted, also, that sometimes a single lenticular hill, prominent and typical in form, is found in an area which nowhere else for many miles shows any similar masses of till. Thus Pigeon Hill in Rockport, 195 feet high, is the only example of this class on Cape Ann.

The distribution of these lenticular accumulations of till in New Hampshire has been quite thoroughly explored during the recent geological survey, and a map of both hills and slopes of this class is presented in the atlas, including also their development in north-eastern Massachusetts as far south as to Ipswich. This map shows that they occur quite abundantly upon three areas which vary from five to twenty miles in width, and extend twenty-five or thirty miles from north to south, or from north-east to south-west. The most eastern of these areas lies mainly in Essex county, Mass., and has already been mentioned. The middle belt reaches from Goffstown and Weare, N. H., south-west to New Ipswich and Rindge, and crosses the state line into Ashby and Ashburnham, Mass. After an interruption of a few miles, these hills are again found abundantly in Gardner. A third belt extends through the west part of Cheshire county, but appears to be quite distinct from the area mentioned in Bernardston, Gill, and Montague. These tracts are separated by others of equal or greater width, upon which scarcely any lenticular hills are found. Farther north in New Hampshire and in York county, Me., lenticular accumulations of till are sprinkled more sparingly, with no traces of system, being numerous in some localities, but generally rare or absent.

The geological reports of Massachusetts and New York gave such descriptions of Plymouth county and Cape Cod, and of Long Island, that these areas have been explored with the expectation of finding lenticular hills; but no accumulations like those which we have been describing under this name were seen. These journeys, however, have been by no means unfruitful; for they have enabled us to determine the extent and character of the terminal moraines which occur there, and have convinced us that the lenticular hills are very different from the deposits that were heaped at the margin of the ice-sheet. These terminal moraines form distinctly continuous, narrow series of hills, which extend hundreds of miles; instead of which, the lenticular hills, though abundant upon certain areas and entirely wanting elsewhere, never are found in any such connected series. The smoothly oval or lenticular shape of the latter is also in marked contrast with the very irregular and broken contour of the morainic hills.

Respecting the very unequal distribution of our lenticular masses of till, or why they should abound in the vicinity of Boston, and in several belts at the north and north-west, while they are very rare or entirely absent upon intervening areas, we can offer no explanation. This grouping does not appear to have been caused by differences in the adjacent stratified rocks; nor is it attributable, so far as I see, to the contour of the land. In our district, and northward, the lenticular hills are finely developed on the low land near the coast, being spread over areas which would otherwise be nearly level; but at many places inland they are equally abundant among high irregular hills of ledge. They seem as likely to be found on one side or another of any mountain or prominent hill-range; and the altitudes at which they occur vary from the level of the sea to fifteen hundred feet above it on the height of land between the Merrimack and Connecticut rivers. If their distribution has been independent of these conditions, as seems to be true, we are brought to the alternative that it probably resulted in some unexplained way from movements of the ice-sheet.

Although we do not discover the cause of the peculiar distribution of these hills, it seems quite certain that they were accumulated and moulded in their lenticular form beneath the ice, instead of being, as has been suggested, remnants spared by the fluviatile and tidal erosion of a once continuous sheet of drift, which was contained in the ice mass and deposited at its melting. Such erosion must have formed table-topped hills, but ours are gracefully rounded, and their slopes vary from 5° to 30°, being steeper at the sides than at the ends; whereas erosion, as may be seen in the islands of the harbor, must have slopes of about 45°. Our lenticular hills, furthermore, are of quite variable size and height, and some which rise only fifty feet above the sea are as typical as neighboring ones one hundred and fifty to two hundred feet high. Another consideration is, that with such removal of equal depths of till from the spaces between these hills, the surface would be left literally covered with boulders which currents of water could not transport.

The origin which the material and trend of these hills have been found to indicate, is therefore to be accepted, though some of its problems remain unsolved. The very hard and compact character of their material, the small proportion of its iron that has become fully oxidized, its very fine, clayey detritus, and its glaciated boulders and pebbles, all show it to be the ground-moraine of the ice-sheet, and the trend of its lenticular masses shows that they were shaped beneath the ice-current. The accumulation of these hills and slopes seems to have been by slow and long-continued addition of material to their surface, the mass remaining nearly stationary from the beginning of its deposition. Obviously this was the case with the lenticular slopes gathered behind the shelter of higher ledgy hills, or upon their opposite sides. Except in this location, these slopes are like the lenticular hills, which seem to contain no ledge, being simply heaps of the ground-moraine fifty to two hundred feet in height. This resemblance suggests that both hills and slopes alike increased slowly in extent and depth without much change in place, new material being lodged upon their surface from the ice-sheet which swept over them.

The obscure lamination or cleavage, which is one of the characteristic features of the lower till, was probably produced by this mode of its accumulation. In this deposit from the ice-sheet, it corresponds to the stratification of sediments from water, but it is less distinct; and the fine detritus in which it appears contains glaciated pebbles and boulders indiscriminately mixed through its whole mass. This structure was at first thought to be a true cleavage, produced by the pressure of the glacial sheet. If we take this explanation, it still proves like the hardness and compactness which also mark the lower till, that this deposit was not ploughed up by the enormous pressure of the ice passing over it. How could this force permit the ground moraine to be heaped in the steeply-projecting lenticular hills? Instead of this we should expect it to be left only in flattened sheets or behind sheltering ledges. The probable answer seems to be that the finely pulverized detritus and glaciated stones in the bottom of the ice-sheet had a tendency to lodge upon the surface of any deposit of the same material. When such banks of the lower till became prominent obstacles to the ice-current, its levelling force was less powerful than this tendency of adhesion, which continually gathered new material, building up these massive rounded hills. At the melting of the overlying ice-sheet, the surface of hills and valleys, ground moraine and ledges, were alike covered by the nearly continuous mantle of the upper till.

Mr. Wright presented a photograph illustrating the formation of loess in the Missouri Valley, taken by Prof. Todd.

Dr. B. Joy Jeffries showed some circulars issued by the Leipzig Museum of Ethnology, for the purpose of obtaining data relating to color perception and color-nomenclature among savage races. Data thus far obtained seem to show that savages have greater powers of discriminating between colors, and even a greater number of color names, than civilized men.

General Meeting. April 16, 1879.

The President, Mr. T. T. Bouvé, in the chair. Fourteen persons present.

The following papers were read:

ON THE MINERALIZED PHOSPHATIC GUANOS OF THE EQUATORIAL PACIFIC ISLANDS. BY SAMUEL KNEELAND, M.D.

In 1872, while strolling along the wharves at Honolulu, Sandwich Islands, I saw a small schooner which had just arrived from Enderbury Island, in the equatorial Pacific. Her cargo was guano; but it looked so unlike the Peruvian guano, and presented such a rock-like appearance, that I spent a week in ascertaining the facts about the deposit, in obtaining specimens, and in having them analyzed. What I present to-night is the result of these inquiries, pursued after I returned, with a few remarks on the ordinary and on other similar Pacific guanos. The subject seems to me interesting from the points of views of Chemical and Economic Geology, Geological Time, and actually occurring metamorphosis of rocks of animal origin.

Guano, as generally understood and used as a fertilizer, consists of the excrements of sea-fowl, urinary and intestinal combined, containing often their decomposed bodies and eggs, the remains of their fishy food, and occasionally the bones of marine animals. It is found accummulated in immense quantities on some of the Pacific islands, and near the coasts of South America and Africa.

Though well known to the ancient Peruvians as a valuable fertilizer the attention of Europe was first drawn to it by Humboldt in 1804; as evidence of the long time it must have required to form deposits fifty to sixty feet deep, he stated that the accumulation of the preceding three hundred years was only a few lines thick. He caused it to be analyzed by the best chemists of the day, who found it to be composed of phosphates of ammonia and lime, with urate and oxalate of ammonia, organic matters and sand. It was not used as a fertilizer in Europe, though Humphry Davy spoke of its value

1819, until 1840; since that time it has been exported from the Peruvian islands in very large quantity.

The three small islands off the south coast of Peru, called the Chincha islands were believed to contain at least forty million tons, the deposit being in some places more than one hundred and sixty feet thick. The demand for it was so great that search was made for other sources of supply, all of which, however, proved inferior to the Peruvian.

The reason of the superiority of the latter is, that no rain falls on these islands, and the ingredients are little changed under their dry tropical sun; the uric acid and ammonia, both readily decomposing under the influence of moisture, remain unchanged and dry. Where rain prevails, these nitrogenous compounds are washed out, and the value of the guano then consists in the amount of the phosphates which remain — this last, or the phosphatic guano, is the one of which I wish to speak to-night.

The differences will be made more plain by a glance at the following analyses:

	Peruvian.	*Jarvis Island.*	*Baker's Island.*
Water . .	12 to 20 per cent.	7.5 per cent.	4.5 per cent.
Organic Matter and Ammoniacal Salts	50 "	4 "	11 "
Soluble Salts	6 "	7.5	7 "
Phosphate Lime	17 to 22 "	81 "	76 "
	98	100	98.5

By Dr. Draper, of N. Y.

The difference in the ammoniacal salts and organic matters which have been washed out in the last two, or rainy islands, and the predominance of the phosphates in these last, to which these specimens belong, will be noticed.

The difference in these guanos is of great importance in their agricultural applications, as it will be readily seen that the rich ammoniacal guanos of Peru would be of little use in light soils, where volatile and soluble parts would easily be lost by being washed out, while the insoluble phosphatic varieties would be better and cheaper.

Jarvis, Baker's and Howland's islands, nearly on the equator, in the Pacific, between 159° and 176° W. long, and a few others in the neighborhood, belonging to the American Guano Company, are quite valuable, containing about ten million tons, and have largely supplied the American market. The island from which these specimens came, Enderbury island, in lat. 3° 8′ S., and long. 171° 8′ W., was not believed until late years to contain any great amount of phosphatic guano.

According to Prof. D. Hague, in the "Amer. Jour. of Science," vol. 34, 1862, whose article has been quoted by Prof. Dana in his work on "Corals and Coral Islands," the following are the characters of the guano of the first three islands just named.

Howland's Island: 0° 51′ N., and 176° 32′ W.

CHEMICAL ANALYSIS.

Lime	42.	36.90
Phosphoric Acid .	39.65	30.80
Sulphuric Acid .	1.33	.58

with a little magnesia and 1 per cent. of carbonic acid.

He speaks of having found buried in the guano fragments of coral, of various species, in which the carbonic acid had been entirely replaced by phosphoric acid, and in such specimens 70 per cent. of phosphate of lime -- some having in the centre a nuucleus or core of coral.

Baker's Island: 0° 13′ N., 176° 22′ W., very remote from any other land, except the last named (about 40 miles N. N. W.). This guano contains also a little magnesia and 1.25 per cent. sulph. acid: with lime 42.34 and phosphoric acid 40.14 — also a little carbonic acid and traces of iron. The surface is covered by a crust, which contains 40.93 of lime, 40.47 of phosphoric acid, 5.66 of sulphuric acid, a very little magnesia, and much sulphate of lime.

Jarvis's Island : 0° 22′ S, 159° 58′ W. In this the principal deposit of guano, according to Hague, rests on sulphate of lime (gypsum), the other soluble salts contained in the ocean water having been washed out by the rains. In fact, he believes that most of the guano taken from these islands rests on a bed of sulphate of lime, some on a coral formation, while some has been mixed with coral mud. The first kind is covered by a hard crust, which may be an inch thick, with the guano beneath; all the guano, if the deposit be shallow, may be in the form of this crust, snowy white or more or less tinged by organic matters, (not by iron), hard, irregular, and friable. In some islands the underlying sulphate of lime may be of a similar color with an admixture of phosphate of lime; this is of little value, but, has been mistaken for and exported as guano.

The phosphoric acid and lime are sometimes combined as bone phosphate, but mostly as a neutral phosphate, and a portion even as superphosphate.

The pure crust contains

Lime	38.62
Phosphoric Acid	50.04
Sulphuric Acid	1.63

a nearly pure diphosphate of lime; or 90 per cent., with an excess of about 3 per cent. of phosphoric acid, even allowing the amount of lime required by the sulphuric acid.

That resting on the coral formation contains.

Lime	42.17
Phosphoric Acid	34.01
Sulphuric Acid	3.06

with a little magnesia and carbonic acid.

These and similar guano islands in the Pacific, are, according to Prof. Hague, in latitudes near the equator where rains occur but rarely; in the rainless Peruvian islands, the true guano occurs. Where rains are very heavy, at 4° or 5° from the equator, the materials are washed away and vegetation is encouraged; the birds then roost in the trees or bushes and no deposits of guano are accumulated. The beds of gypsum, or sulphate of lime, remain after the evaporation of the sea water, which holds it in solution, in the gradually drying lagoon.

Wherever large numbers of sea fowl frequent islands for the purpose of laying their eggs, guano may be deposited; but rains, as we have seen, by washing away the organic matters produce a very different substance, chemically, from true guano.

Enderbury Island, from which these specimens came, is two and three quarter miles long, by one mile wide, trapezoidal in form, and about eighteen feet above the sea at low tide, this rising about six feet. The beach is about twelve feet high, the first eight with a regular slope of 30° to 35°, made up of sand, pebbles, and rounded stones of coral, with a few shells; it is then horizontal, according to Dana, for eighty to one hundred feet, and then comes a gradual rise of three or four feet; the corals are principally immense foliaceous madrepores, some twelve to fifteen feet in diameter; many fragments on the beach are four inches thick, with thirty square feet of surface.

Above the crown of the beach is a sandy ridge which encircles the guano deposit, nearly even, though the hard coral bottom of the bed slopes toward the centre, the depth of the guano varying from one-half to several feet. There is little vegetation and few trees; the lagoon is very shallow, containing no growing coral; its shores are of coral mud, which allows the foot to sink into it eight to ten inches, rendering it difficult to reach its waters; the mud looks like a dirty brownish clay, but is nothing but very finely comminuted coral; the water of the lagoon is occasionally salt, and its shores are in some places incrusted with salt.

The climate is equable, the temperature ranging from 76° to 80° Fahr., in the shade; easterly trade winds are constant, in summer with northing, in winter with southing; sky usually clear and cloudless; light showers are not uncommon, though heavy ones are unknown, and there is never a rainy day. There are no mammals on the island except rats, which feed on eggs; it is occasionally visited by turtles, and by civilized man; and it is not unlikely that bones of various marine animals may occur in the deposit, and I think some of the specimens afford evidence of this. As there is no fresh water upon the island except what is caught during rains, and no food to depend upon except fish, birds, and their eggs, vessels employed in collecting the guano have to carry their own supplies, causing considerable privation when from baffling winds supplies fail to reach them in proper time.

The birds most abundant here are the tern (*Sterna hirundo*), which comes in millions twice a year to breed, resting on the ground, making no nest, but getting under tufts of grass where any exist — noddies, (*Anous stolidus*), which burrow in the guano, — boobies and gannets (*Sula fiber* and *bassana*) great devourers of fish, which they disgorge when feeding their young or when alarmed — petrels (*Procellaria*), tropic birds (*Phaeton*), and frigate birds (*Tachypetes*) — all of these contribute to the formation of the guano.

There are several varieties of this mineralized guano, differing in the amount of the phosphates contained.

1. A sandy or granular kind without ammonical odor, of which the average composition, from another locality, according to Dr. A. A. far as Hayes is, as the salts of lime are concerned:

Bone Phosphate of Lime . .	46.60
Carb. of Lime	39.80
Organic Matters	6.40

II. Aggregated grains, the first step in the conversion into rock, and differing from I, chiefly in the greater proportion of phosphate and the less proportion of carbonate of lime.

III. A solid rock, the product of chemical changes, by which carbonate of lime is lost and phosphate of lime increased, in varying proportions as the specimens show on analysis. The carbonates are decomposed by heat and moisture, and with other soluble matters are removed by rain; the passage of the escaping gases through the mass, like the carbonic acid in the raising of dough which we bake into bread, renders the structure somewhat light and cellular, so as to resemble and to be mistaken for a trachytic rock, of igneous or metamorphic origin. In some cases the structure is so compact and hard as to resemble a feldspathic mineral or a weathered trap — even resembling the phosphate of lime rocks of the older crystalline formations. Mr. A. A. Julien (Amer. Jour. of Science, Vol. 40, 1865,) has drawn attention to the rock guanos of the West Indies and the Eastern coast of South America, especially Sombrero Island, 18° 36′ N. and 62° 27′ W., where it occurs in veins through beds of limestone — with pseudomorphs rich in the bone phosphate, even 85 per cent., phosphoric being substituted for carbonic acid brought down by the rains into the joints of the limestone. These rocks also contain crystals of Brushite, containing 96.8 phosphate of lime — of Metabrushite, 95 per cent., with one less equivalent of water — also two varieties, Zeugite with 85 per cent, and Ornithite with 94 per cent.

The varieties of all these rock guanos differ much in proportions of phosphates of lime. The oolitic or granular form, of many colors, contains both the bone or tribasic phosphate ($3\ CaO, PO_5$), and neutral bibasic phosphate ($2\ CaO, HO, PO_5$), with some phosphate of alumina, iron and manganese — evidently formed largely from, according to Dr. A. A. Hayes, fish bones and shells acted on by the acids of the guano — as stated below.

The concretionary form, as in these specimens, has its upper surface covered with rounded elevations and nodules, as in all compact calcareous concretions; this is white or yellowish or even reddish white, with a little carbonate and sulphate of lime, but rich in the bone phosphates. The interior is full of cavities and irregularities, with a splintery fracture, and a hardness nearly equal to that of feldspar. This is the more recent, bearing evidence in its cavities and agate-like lamination of the percolation and slow evaporation of waters ; there is no evidence of high temperature, great pressure, or action of heated waters, but only of what might be called atmospheric and surface agents of percolating guano solutions.

Such material, if not available as guano, may be used in making the superphosphate of lime for fertilizing purposes; as such it has been imported by the cargo from the coasts of Venezuela and Guiana. Dr. A. A. Hayes, in the Proc. of Bost. Soc. Nat. History, Vol. vi, 1856, p. 48–50, has thrown much light on these phosphatic guanos of the rainy islands, while treating of the state in which phosphate of lime exists in water, and of the action of the latter on bones, viz: one proportion of the tribasic or bone phosphate of lime is taken out by the carbonic and crenic acids developed during the putrefaction of the gelatine of the bones; this leaves the bibasic, more soluble phosphate, in solution; as the process goes on, a simple or monobasic phosphate remains, and even this may be so far dissolved as to approach the state of phosphoric acid in solution and carbonate and crenate of lime deposited — then by disintegration of the last named salts, the lime is set free, ready to combine again with the phosphoric acid. In the Enderbury guano, however, no such layer of fish bones can be called in to account for the phosphatic character of the deposit. Water containing carbonic acid from decomposed coral, or from any slight layer of vegetable matter on the surface, would exert a solvent action on the carbonate of lime, and would leave behind the phosphate of lime belonging to the organic matter of the guano. The formation of the phosphates in nature is not well understood; we cannot attribute them here to vertebrate remains, nor to the shells of brachiopods or pteropods, nor any marine organisms, animal or vegetable.

The following are the analyses of the Enderbury specimens — the powdered specimens in the bottles, marked 1, 2, 3, by the Company's chemist on the island — the others in the Laboratory of the Mass. Institute of Technology, by Mrs. E. H. Richards and Miss M. O. Glover; the first three in January, 1873, the fourth in Jan., 1879:

No. 4 contains . .	41.898	Phosphoric Acid.
	1.260	Carbonic Acid.
	45.32	Lime.
Equivalent to . .	91.48	Tribasic Phosphate of Lime.
	2.86	Carbonate of Lime.
	5.52	Water and Organic Matter.

No. 5 contains	41.25	Phosphoric Acid.
	1.76	Carbonic Acid.
Equivalent to	90.07	Phosphate of Lime.
	4.00	Carbonate of Lime.
No. 6 contains	38.76	Phosphoric Acid.
	7.48	Carbonic Acid.
Equivalent to	84.63	Phosphate of Lime.
	17.00	Carbonate of Lime.

Though having a reddish color, no iron was present.

A complete analysis of No. 5, gave the following result: —

Phosphoric Acid (P_2O_5)	41.25
Carbonic Acid (CO_2)	1.76
Lime (CaO)	49.60
Alumina (Al_2O_3)	3.86
Soda	trace
Water and Organic Matter	3.63
	100.10

Magnesia, Potash, and Silica apparently present, but undetermined.

No. 7 contains	29.5	Phosphoric Acid.
Equivalent to about	64.00	Phosphate of Lime;

the remainder is merely Carbonate of Lime, with a small amount only of Sulphate.

Many of the specimens present a nodular appearance, of various sizes, with geode-like prominences and communicating cylindrical canals, lined with horn-colored or blush-white incrustations — mingled with irregular cavities, more or less narrow and longitudinal, with well marked concentric striæ of deposition — gradually passing into a firm rock by subsequent chemical action.

From the explanation of Dr. Hayes above given, it might well be that this trachytic form should be consolidated under water, by a subsidence of the land after it had been deeply covered with organic remains; after such mineralization, it may be again raised above the surface, and again become the resort of guano-making birds. Guano may, therefore, be a geological formation, even of tertiary age, resembling the massive phosphate of lime (apatite) of New Jersey.

Dr. Chas. T. Jackson, (Proc. of this Society, Vol. xi, Feb. 19, 1868), presented two specimens of fossil or submarine guano received from a plantation in the vicinity of Charleston, S. C., showing on analysis, 60 per cent. of phosphate of lime, 10 of carbonate of lime, 2⅓ of organic matter, 2⅔ of soda, and 20 of silicious sand — or phosphoric acid 32.29, and lime 28.79 — it was filled with casts of shells, apparently of *Terebratulæ*, probably of tertiary age. The South Carolina beds of phosphates are so accessible, that their products have almost entirely superseded the guanos in the Southern States where they are most required and used.

It seems to me that these specimens afford a remarkable instance of the conversion of modern deposits of organic substances into what appears to be an old rock; though known to be modern, and to be in process of formation at the present time, all traces of animal origin have as completely disappeared as in the metamorphic rocks which we are accustomed to ascribe to the combined action of intense heat, enormous pressure, and long periods of time. They are interesting, too, as stated in the beginning, from the points of view of Economic and Chemical Geology, and perhaps of Geological Time.

	Lime.	*$P.O_5$.*	*Phos. Lime.*	*Carb. Lime.*	*$S.O_3$.*	*Sulph. Lime.*	*Am'ml. Salts.*	*Soluble Salts.*	*Water.*
Peru			20				50	6	16
Jarvis Is.			81				4	7.50	7.50
Baker's Is.			76				11	7	4.50
Jarvis' Is.	38.62	50.04	90		1.63				
" "	42.17	34.01			3.06				
Baker's Is.	42.34	40.14			1.25				
" "	40.93	40.47			5.66	much			
Howland's Is. . . .	42	39.65			1.33				
" " . . .	37	30.8			.58				
S. Am. Is.			85.20	3.00					
" "			46.60	39.80			6.40		10.
Enderbury Is. . . .	45.32	41.90	91.48	2.86					
" "[1] . . .	49.60	41.25	90.07	4.00					
" " . . .		38.76	84.63	17.00					
" " . . .		29.5	64.00	much		little			
S. Carolina	28.79	32.29	60.00	10.00			2.34		
Sombrero			85 to 96						

[1] *Complete Analysis.*— Carb. Acid 1.76 — Alumina 3.86 —Water and organic matters 3.63 — Soda, a trace— Magnesia, Potash, and Silica apparently present, but undetermined.

Bottle specimens—Phosphate Lime: (1) 79 per cent.; (2) 75 per cent.; (3) 70 per cent.

Dr. Kneeland also described the phenomena of the frozen well at Decorah, Iowa.

This is situated at a depth of 50 to 60 feet in a rocky bluff about the same height above the river, and 125 feet from the lateral face of the bluff. It is a small, irregular-shaped cave, into the top of which water trickles from the surface through a narrow cleft, probably caused by a fault. In summer the sides and bottom of the cave are covered with ice, and in winter with a muddy slush.

He thought the explanation of Mr. N. M. Lowe, of Boston, ingenious and probable, viz.: that in summer the water passed down the crevice, carrying with it air; this air, in descent of 50 to 60 feet, would be much compressed; and when the mingled water and air escaped into the cave, the sudden expansion of the air would take so much heat from the water, or create such a cold, that ice would be formed. In winter when the outer surface of the bluff is sealed over by ice, no water nor air could enter, and the summer ice would be melted into the semi-fluid mud then found.

As the cave is independent of the changes of external air according to season, and is in the interior of a high, rocky bluff, no glacial remains, or similar geological cause, would seem adequate to explain the phenomenon.

The thanks of the Society were voted to Messrs. E. A. and O. Bangs, G. O. Welch, and Harry Merrill, for gifts to the New England Collection of Birds.

Annual Meeting. May 7, 1879.

Vice-President Mr. S. H. Scudder in the chair. Thirty-nine persons present.

The following annual reports were presented: —

Report of Prof. A. Hyatt, Custodian.

The work of the Society and the condition of its collections during the past year call for no special remarks which will not appear under the separate headings in this report.

The minerals are in the same good condition as formerly, and the preliminary work necessary for the preparation of a catalogue has been begun, and is being actively pressed forward by Mr. Bouvé.

The re-arrangement of the Geological Room, and the mounting and cataloguing of the specimens is being now carried on by Mr. Crosby, assisted by Miss Carter. This change has been made necessary by recent advances in science, especially in Lithology. The plan of operations also embraces the formation of a New England Geological collection.

The work so far has been expended on the Lithological collection, and has included the formation of a series of about one hundred specimens, illustrating the principal minerals constituting rocks, and a collection of about eighty specimens, showing the principal textures of rocks.

The principal accession in this department for the year consists of a suite of 250 specimens of the typical rocks of New Hampshire, collected by the recent Geological Survey of that State, and received in exchange from Prof. C. H. Hitchcock.

The revision of the Palaeontological collections has been finished during the year. The general plan of this department, and the features of special interest and value have been described in previous reports. Since the beginning of this work, Mr. Crosby has been assisted by Miss Carter and Miss Washburn, the former working upon the collections from Europe, Asia, and Africa, and the latter upon those from North and South America.

The North American collection was really finished at the beginning of the year, but the following accessions have since been received, mounted, and labelled: —

Forty specimens of Cambrian, Silurian, and Devonian fossils, collected by Prof. F. H. Bradley, and given by Mr. John Cummings.

A collection of nearly 500 subcarboniferous crinoids has been obtained by exchange from Prof. A. H. Worthen, State Geologist of Illinois.

One hundred and twenty-five specimens of Cretaceous fossils from Texas, obtained by purchase from Mrs. D. H. Walker. One hundred specimens of Cretaceous vertebrate remains from Kansas, purchased from the State Geologist, Prof. B. F. Mudge.

With these two additions, our Cretaceous collection has come to compare favorably with those of the other North American formations.

In the New England collection I have to note the accession of twenty specimens of fossiliferous rock, probably of Eocene age, from the drift of Truro on Cape Cod. These were given by Mr. Warren Upham.

Adding the foregoing to the figures submitted last year, the North American collection is found to consist as follows:

	Genera.	*Species.*	*Specimens.*
Cambrian	112	214	645
Silurian . . .	136	241	656
Devonian . . .	208	376	1127
Subcarboniferous .	99	215	650
Carboniferous . . .	79	288	1089
Triassic . . .	35	29	51
Jurassic . . .	5	5	40
Cretaceous . .	90	177	883
Tertiary and Post-tertiary	306	548	3086
	1070	2093	8227

The Triassic fishes and plants, and most of the foot-tracks, as well as a good collection of Devonian bivalves, and several other small lots of fossils which have never been identified and are for the most part unmounted, are not included in the above summary.

The names of the corals, and of some other fossils of the Cambrian, Silurian, and Devonian formations have been revised, in accordance with the recently published reports of the Geological Surveys of Michigan and Ohio, and the fifth volume of the Palaeontology of New York.

The collection from South America, including the West Indies, is almost insignificantly small; and, with the exception of one species of ammonite from the Cretaceous, all the specimens are Tertiary or Post-tertiary. In all there are about 24 genera, 28 species, and 170 specimens. The most of the material is undetermined, which explains the small proportion of species. This collection has been mounted during the past year.

From Africa, the number is still more scanty, comprising only 5 genera, 6 species, and 14 specimens, all Tertiary, except one Post-tertiary.

The Asiatic collection, including specimens from the Malay Archipelago, Australia, and Oceanica, has also been mounted this year. It contains many large specimens, consisting chiefly of casts of Miocene mammalia, from the Sivalik Hills in Hindostan; but besides these there are Cretaceous fishes from Mt. Lebanon, and casts of Carboniferous shells from Australia; also casts of the bones of the Dinornis and Palaeopteryx from New Zealand. This collection is numerically about the same as that from South America, aggregating 46 genera, 84 species, and 170 specimens.

The principal work done on the European collection this year, has been to mount the Palaeozoic fossils, and a collection of 380 specimens, representing various formations, received in exchange from Mr. John Cummings.

The Eser portion of this collection, so far as mounted, was reported on last year.

Following is an enumeration of the entire European collection:

	Genera.	*Species.*	*Specimens.*
Cambrian . . .	4	7	9
Silurian . . .	49	81	96
Devonian . . .	42	87	254
Subcarboniferous .	10	37	75
Carboniferous . .	6	10	68
Triassic . . .	8	26	84
Jurassic . . .	79	281	1347
Cretaceous . .	88	170	716
Tertiary and Recent .	38	261	2197
	325	960	4846

Adding together the aggregates of the different collections given above, we obtain the following totals for the whole department:

	Genera.	Species.	Specimens.
No. America	1070	2093	8227
So. America	24	28	170
Africa	5	6	14
Asia and Australia	46	84	170
Europe	1631	3623	13655
	2776	5834	22236

Mr. W. O. Crosby has carefuly sorted the large collection of duplicate fossils, selecting out a good suite for teaching Stratigraphical Palaeontology, while a large proportion of the more common and typical of the fossils remaining have been divided into small sets, to be disposed of to teachers and and students, the residue being retained for ordinary exchange purposes.

A large number of these duplicates have been temporarily loaned to the Institute of Technology, for use in teaching in their Geological Department.

Now that the arrangement and cataloguing of these collections is finished, it will probably not surprise the Society to learn that their condition is attributable not only to the liberality of Mr. John Cummings in giving valuable collections, but more than anything else, to the work done by the two assistants employed by him. Without this aid we could have done but little more than preserve in their former condition the departments of Palaeontology, Botany, and Microscopy; certainly, we could not have arrived at our present satisfactory state in these collections. Though our progress in the Museum is so largely due to this gentleman, there is no way in which the Society can express its obligations, except through this Annual Report, since by far the largest part of his annual donation never appears upon the Treasurer's books or other printed records.

During the past year the specimens of wood, fruit, etc., on exhibition in the glass cases, have been catalogued, mounted on tablets, and marked with printed labels by Miss Carter. There are 2583 specimens, representing 304 genera, and 492 species.

Mr. C. J. Sprague has given us 300 specimens of dried plants, 250 of which are from Florida, collected by A. H. Curtiss, and 50 are rare New England species collected by C. J. Pringle, of Vermont. These are all fine specimens, and have been mounted and placed in their respective places in the Herbarium.

The work of sorting the duplicates and filling the gaps in the General Collection therefrom has been steadily progressing under the direction of Mr. Cummings.

Mr. E. T. Bouvé has kindly continued his work upon the trees and shrubs of New England, a number of species having been added to the collection.

The work upon the Anatomical department has been in great measure suspended, but a new section of this collection has been established, and many new preparations made. In this new section there are now brought together preparations made by Mr. Van Vleck exhibiting the general anatomy of the invertebrates and the typical forms of the different subdivisions of the animal kingdom. They are temporarily exhibited in floor cases, which have been constructed out of the old cases which formerly served in the Mason street building to hold the shells. These are economical, but can hardly be described as either safe or ornamental.

The final report upon the collection of Shells, which was promised in the last Annual Report, cannot be given on account of the sickness and prolonged absence of Miss Washburn, whose services were necessary for the completion of this part of the work. Mr. Van Vleck worked over the duplicate sets returned from the estate of Dr. Carpenter, and has done the preliminary work upon the mass of other duplicates. The collection is in reality finished, with the exception of a few families of minute mollusca, which were not named by Dr. Carpenter before his death.

Mr. Henshaw reports that the Harris collection of Hemiptera heteroptera has been arranged and labelled according to Mr. Uhler's report.[1] The assortment and arrangement of the alcoholic material is about half completed, and some progress has been accomplished in bringing together a collection of all the types described by authors in the Proceedings of this Society. Large numbers of specimens were collected by Mr. Henshaw during the summer, but only a small portion has been worked over. Considerable time has been expended on the New England collection, which now contains 3375 species, and 8003 specimens.

Important donations have been received, one from Mr. F. C. Bowditch of useful insects of all orders; another from Dr. C. S. Minot of his entire collection of insects, which contains some very desirable additions to our general and New England collections; a part of a collection put up by the late Mr. Gurdon Saltonstall, a student of unusual promise, whose death was bitterly regretted by many prominent members of this Society, has been presented by his family; and a number of noctuids, of which we stood much in need, have been received from Mr. Roland Thaxter.

Mr. Henshaw has been constantly employed as assistant in the Teachers' School of Science, and has had but little time to spare for work upon these collections, but this has been gratuitously given to the Society.

The Fishes remain as heretofore, though it is very desirable that, in the New England collection, the types of Dr. Storer's fishes, destroyed in former years by neglect, by drying up of the alcohol, and by insects-pests, should be replaced, as has been done for other similar collections of types among the insects and other branches. This work was begun by the Custodian in the summer of 1871, when a special effort was being made under the generous patronage of Mr. C. J. Sprague to fill out the collection of New England species. Unfortunately this work could not be continued in succeeding seasons, and cannot now be resumed for want of means.

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[1] Proc. of this Society 1878, XIX, 365.

The Reptiles were worked over in the early part of the year by Mr. Van Vleck, and also by Mr. Garman of the Museum of Comparative Zoology, and the latter has returned a number identified and named.

The Mammalia remain in the same disgraceful condition as during former years.

Through the exertions of Dr. Brewer, the New England collection of Birds has considerably increased, some thirty or forty species having been added, of which a detailed list will be published hereafter. The humming birds have been carefully worked over by this gentleman, and will be ready for publication after the appearance of the Elliott Synopsis which is to be issued by the Smithsonian Institution.

During the summer of 1878, the Custodian, assisted by Mr. Van Vleck and Mr. Edw. G. Gardiner, collected at Annisquam, Mass. Much work was done, but the boat used was found, when too late, to be too small for off shore work in this locality; which fact, and the want of proper means otherwise, explain results inadequate to the amount of labor expended. Several fine anatomical preparations were, however, made, and an experience gained which will doubtless be useful in the future.

LABORATORY.

The activity of this department continues to be a matter of congratulation. The collections have been greatly improved, and many preparations added to those on hand. The room and these collections have been used for the past year by a class in Zoology and Palaeontology, from the Mass. Institute of Technology, one in Zoology, from Boston University, and one in Zoology, composed of the teachers of the Boston High Schools. A full account of this last class, and the prolonged course which it has now nearly completed, was given in the last Annual Report.

TEACHERS' SCHOOL OF SCIENCE.

The Teachers' School of Science has this year attained extraordinary size and importance. So sudden and unexpected was this development, that for the last six months it has almost completely arrested all efficient work in other directions. The study of nature having been introduced in a definite form into the public schools, and the supervisor of this department, Miss Lucretia Crocker, having assured us that our assistance would be of great benefit, and was in fact essential, it was determined to institute appropriate courses upon elementary Botany, Zoology, and Mineralogy, if the means of paying the expenses could be raised. Mrs. S. T. Hooper and Miss Crocker undertook and successfully completed this part of the work, and also a considerable amount of harassing clerical labor, which subsequently arose out of the success of their own exertions. Fortunately for their scheme these ladies met with substantial appreciation from Mrs. Augustus Hemenway, who both subscribed most liberally, and also encouraged them to accept the very considerable pecuniary responsibilities, which began to block their way at the very beginning of operations. In fact, without these assurances of further support and interest, we should not have dared to begin.

These obstacles arose from two causes, the number of applicants, and the necessity of providing identical specimens for all. The specimens and materials for two hundred, which was the maximum number anticipated at first, could have been readily furnished, but when the applicants reached six hundred, it became exceedingly questionable whether such a number could be provided for, and properly instructed by one person, all at the same time. Feeling, however, that the cause of science demanded that these difficulties should be met and supported, and relying on the hearty coöperation of Prof. Goodale and the ladies mentioned above, the course was begun.

The association and sympathy of Mrs. Elizabeth Agassiz with the undertaking has been particularly gratifying, since Prof. Louis Agassiz was the first naturalist who ever taught a popular audience in this country with the specimens in hand.

The enterprise was in large part the work of women and affords pleasing evidence of the activity and usefulness of this new class of members in our Society.

The following is a list of the donors:

Mrs. Augustus Hemenway	$1000.00
Anonymous	500.00
Mrs. John M. Forbes	100.00
Miss A. S. Hooper	100.00
Mrs. H. P. Kidder	100.00
Miss M. A. Wales	50.00
Mrs. Sarah S. Russell	50.00
Mrs. John E. Lodge	50.00
Mrs. Richard C. Greenleaf	50.00
Miss Anna C. Lowell	50.00
Mrs. E. W. Gurney	50.00

Smaller sums were contributed by Mrs. Elizabeth C. Agassiz, Mrs. Samuel Hooper, Miss S. Minns, Miss E. Mason, Miss M. C. Jackson, Miss Stone, Miss Abby W. May, Mrs. James Freeman Clarke, Miss Cora H. Clarke, Miss Lucretia Crocker, Mrs. Thomas Mack, Mrs. A. S. Farwell and others.

Many of these ladies were very active in securing the success of the course and the Society thanks them and others; especially Mrs. E. D. Cheney, Miss J. M. Arms, Miss C. J. Ireland, and Mrs. Samuel Wells for their personal efforts in behalf of the Teachers' School of Science.

The teachers themselves, at our solicitation, joined in making up the fund.

The number of the schools which contributed may have occasioned some few omissions, especially as many must have been represented by personal contributions which were made at the lectures and could not be credited to any particular school.

The Society returns thanks to all these unknown donors as well as to those on the following list of Schools.

Andrew	$9.00	Brought forward	$326.50	
Allston	7.00	Hawes	4.00	
Bennett	3.00	Hillside	3.00	
Brimmer	8.50	Horace Mann	15.00	
Bowditch	20.00	Lewis	8.00	
Bigelow	7.00	Lawrence	13.00	
Bowdoin	12.00	Lyman	6.00	
Bunker Hill	24.50	Minot	28.00	
Comins	12.00	Mather	6.00	
Central	3.00	Newton	3.00	
Chas. Sumner	23.50	Norcross	13.00	
Drake	1.00	Normal	15.00	
Dudley	15.50	Phillips	9.00	
Dwight	24.00	Prescott	7.00	
Everett	66.00	Rice	14.00	
Emerson	8.00	Shurtleff	18.50	
Eliot, W. Roxbury	3.00	Sherwin	12.00	
Frothingham	10.00	Stoughton	17.00	
Franklin	20.00	Tileston	3.00	
Gaston	11.00	Watertown	6.00	
Hancock	19.50	Warren	28.00	
Harris	19.00	Winthrop	10.00	
				$575.00
Teachers from Quincy				42.00
" " various schools				172.00
		Total,		$789.00

Notwithstanding this generous assistance, it would hardly have been possible to carry on the several courses without the friendly aid and direct assistance in various ways of the following institutions and persons:—

The Institute of Technology, which most generously gave us the use of Huntington Hall, upon the payment of a merely nominal sum for cleaning and heating.

The Museum of Comparative Zoology, under the direction of Mr. Alexander Agassiz, which, through Count Pourtalés, Dr. Hermann Hagen, and Mr. E. C. Hamlin, at various times assisted us by donations of specimens from the respective departments superintended by these gentlemen.

Mr. Henshaw, my right hand assistant in all the work of preparation and distribution, whose untiring energy contributed largely to secure the success of every lesson; Miss Hintz, of the Normal School, who drew with remarkable skill the diagrams used in the Zoological course, and enabled the Custodian to illustrate fully all subjects; Mr. Van Vleck for aid in the preparation of models; Mr. L. S. Burbank; Miss Nunn, Prof. of Biology at Wellesley College; Mr. E. R. McCarthy, of New York; Capt. Horsfall, of Steamer Canopus; Mr. Eugene G. Blackford, of New York; and the proprietors of the Parker House and Young's Hotel, for donations of specimens and assistance in various ways.

Mr. E. G. Gardiner, Mr. E. A. W. Hammatt, Mr. G. H. Barton of the Institute of Technology, have also kindly assisted at the lectures in various capacities. To many of my own students, teachers, and others I am also indebted for assistance.

Since the lectures were begun in 1871, they have been continued without interruption, except during the winter of 1872-73, under the patronage of Mr. John Cummings; and previous to this winter about 75,000 specimens of minerals, plants, and animals had been studied and distributed to teachers of the public schools. The application for tickets rose during those years from an average of 55 to 166.

The number of recorded applications for the course now approaching completion is 616, or nearly four times as many as in previous years, and the number of specimens which will have been distributed during this winter alone cannot fall short of 100,000.

After an introductory lecture in which the Superintendent of the Public Schools, the President of the Society, and the Custodian delivered addresses appropriate to the occasion, Prof. Goodale completed a course of six lessons on Botany in which he instructed the whole audience of five hundred with apparently as much readiness as if it had been but fifty. Mr.

Jackson Dawson, Mr. Watson and Mr. Greenleaf were of great assistance to Professor Goodale in the procuring of the vast number of live plants and the great amount of other material required for his lessons. Mr. Charless W. Spurr, 522 Harrison Avenue, Boston, prepared, for the purpose of illustrating the subject of wood sections, 500 packages of excellent specimens of the following woods: Tulip-tree or Whitewood, Rosewood, Ash, Oak, Pine, Mahogany, Walnut, Butternut, Maple, Cedar, Birch, Cherry, Elm and Holly. Many of these were in duplicate, exhibiting both plain and figured texture. The specimens, more than ten thousand in all, were gratuitously presented to the class by Mr. Spurr.

The Custodian followed with twelve lessons on Zoology, which will be completed on the 10th of this month, and Mr. Burbank is to continue with five on Mineralogy. The average attendance, on fair days, so far, has been about five hundred.

The course was supplemented by the publication of a series of small pamphlets, under the general title of Science Guides, which were intended to assist the teachers in the application of the knowledge imparted by the lectures. These are described in the Report of the Secretary.

Perhaps the most gratifying and encouraging facts are derived from an examination of the statistics of the past seven years. Thns out of the 616 applicants of this winter, there are 155 who had attended at least one previous course,[1] 119 who had attended two more previous courses, and 44 who had attended all of the courses. Some of these last, I may add, are masters of Public Schools.

Therc is a general impression that the Society derives material benefits from such undertakings. Many people also have the impression that we are rich, because we have large expenses and support a building upon the Back Bay lands, and have a Museum open to the public. We have indeed learned how to keep out of debt, and how to make some progress with insufficient means, but we have not yet learned that donations of time and money to the public service on our part are in any sense remunerative.

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[1] It must be remembered that the highest number of attendants at lessons reached in previous years was 166.

I will mention for example that the present course has cost the Society a year's delay in the preparation of the General Guide to the Museum, about $1000 in the shape of the Custodian's salary during the time in which they had no direct return for his personal services, a considerable amount of work in the Museum by Mr. Henshaw, some of Mr. Van Vleck's time, and some also of the janitor's time. Such expenditures as these are not even distantly related to the kind of investments which men make when they expect tangible returns in the shape of interest moneys, or which purely scientific societies would select for a similar purpose, or even to stimulate donations.

Report of Mr. Burgess, Secretary.

In preparing my annual report for the present meeting, it seems fitting to compare briefly the condition and work of the departments under the Secretary's charge, during the years of the decade now closing. The history of these ten years is the common one of large, possibly extravagant, expenditure during the earlier half, and of an ever increasing reduction and economy in the later. On the departments in question, at least, the Society has spent a smaller sum during the present, than for many a year past; owing, however, to the constant watchfulness of the various committees in charge and to the prevailing lower prices of labor and materials, as much has been accomplished as could be claimed in several preceding reports, and the present condition of these departments warrants a hopeful prophecy for a future, I trust not far distant.

MEMBERSHIP.

The resident membership of the Society now includes 441 Corporate and Associate members, about fifty less than given in the Annual published ten years since. Probably, however, the number of members to whom we look for the payment of annual assessments, is larger than at that time, owing to the smaller number of life members, and the care taken in drawing up the roll. Indeed, the Treasurer's last report showed the largest income ever received from this source; although the one to follow, I am sorry to say, will probably show some falling off. Twenty-four Associate, five Corporate, and fourteen Corresponding Members have been elected during the past year, and all but two of the former class have completed their membership. Two members have purchased commutation for the annual assessments.

It would seem desirable to publish a new list of members as soon as possible, as this has not been done since the publication of the so-called Annual.

MEETINGS.

Sixteen meetings of the General Society, seven of the Section of Botany, and eight of the Section of Entomology have been held the past year. The average attendance has been twenty-two, eight, and eleven, respectively, showing a falling off lately at the general and botanical meetings, while the meetings of the Sections of Entomology have been unusually well attended and interesting. The average attendance, given by Mr. Scudder ten years ago, was exactly the same for the general and entomological meetings; — the Section of Botany had not then been formed. The history of this latter section, begun under hopeful auspices three years ago, is far from satisfactory. With so much popular interest in the study of Botany, the result was unexpected, and is to be regretted.

LIBRARY.

The present condition of the Library is as good as could be hoped, considering the sum spent upon it. The council have, fortunately, been able to appropriate a small amount for binding, with which a beginning has been made in this sorely needed work. The income of the Wolcott Fund has been much reduced, and the additions by purchase have been very small. Of these the most valuable have been Parts 36–59 of Dresser's Birds of Europe. The total year's additions number 1,692, which exceeds the figures for seven years of the decade. In 1870 the library included 9,396 vols. and 2,677 pamphlets, maps, etc. At present there are about 16,000 vols. and 4,500 pamphlets, etc.

We are indebted this year to the Museo Civico di Genoa for a valuable and complete series of its publications. Also to Prof. Joachim Barrande of Prague, for a set of his extensive works, and to Prof. J. O. Westwood of Oxford, for a number of his papers.

The classification of the additions is:—

	8°.	4°.	Fol.	Total.
Volumes	215	35	2	252
Parts	807	194	4	1005
Pamphlets	191	21	2	214
Maps and Charts				221
				1692

The usefulness of the Library as shown by the number of books borrowed from it, has never been so great,—1,169 books having been taken out by 123 persons. The Library rooms would be improved by the addition of new chairs and tables for the use of those frequenting them.

PUBLICATIONS.

The sum spent on our publications has been less than for many years,—still the amount of matter published has been exceeded only in four years of the decade. The third volume of "Memoirs" has been begun by the publication of two numbers:—

On Distomum crassicolle: with brief notes on Huxley's proposed Classification of Worms. By Charles Sedgwick Minot. pp. 30. One Plate.

The Early Types of Insects: or the Origin and Sequence of Insect Life in Palaeozoic Times. By Samuel H. Scudder. pp. 9.

A third number is in preparation. A new volume of Occasional papers — the third — is also in press, and will be issued during the summer. It contains Mr. W. O. Crosby's Geology of Massachusetts, and will form a volume of about 350 pages with colored maps and plates.

The nineteenth volume of Proceedings has been completed by the publication of two quarterly parts, and the first part of vol. xx has been issued.

Besides the regular publications, a series of "Guides for Science Teaching" was experimentally undertaken in January. These were intended to accompany the courses of lectures to teachers already described by the Custodian. Three numbers (About Pebbles, by Prof. Hyatt; A Few Common Plants, by Dr. Goodale; and Commercial and other Sponges, by Prof. Hyatt), were published, the cost being defrayed by sales, when Messrs. Ginn & Heath, the well-known publishers of school books, offered to carry on the work, which was accordingly placed in their hands. A fourth number has since been published, a fifth will appear this week, and a further continuation of the series has been arranged.

Our exchange list now numbers 352 Societies or journals, of which 50 are United States and Canadian. This number does not exceed that for 1870, although many new exchanges since that time have been arranged. Many names then on the list, however, did not represent actual exchanges, and have since been dropped, and the list is larger than that of any similar body in the United State, excepting, of course, the Smithsonian Institution.

Nine new exchanges have been added during the year: —

The Midland Naturalist, Birmingham, England.
Sociedad Cientifica Argentina, Buenos Aires.
Societa Crittogamologica Italiana, Milano.
Société Philomatique de Paris.
Zoologischer Anzeiger, Leipzig.
Cambridge Entomological Club, Cambridge, Mass.
New York Microscopical Society.
Department of Agriculture, Washington.
Science News, New York.

REPORT OF MR. SCUDDER, TREASURER.

ANNUAL STATEMENT OF RECEIPTS AND EXPENDITURES, MAY 1, 1879, BOSTON SOCIETY OF NATURAL HISTORY.

May 1, 1878, to May 1, 1879.

Annual Assessments	$1495.00
Admission Fees	115.00
Walker Fund Income	3199.42
" Prize Fund Income	212.00
" Grand Prize Fund Income	108.00
Bulfinch Street Estate Fund Income	1550.00
Courtis Fund Income	224.00
S. P. Pratt Fund Income	795.54
H. F. Wolcott Fund Income	240.00
Dividends and Income from General Fund	3298.32
Entomological Fund Income	20.00
Laboratory Students' Fees	375.00
	$11,332.28
Excess of Receipts over Expenditures	$835.90
Reserved in accordance with conditions of "Walker Bequest."	
Teachers' School of Science—	
Received from Donations from Individuals	1556.00
" " Sale of Tickets to Lectures	726.52
	$2282.52

May 1, 1878, to May 1, 1879.

Library		$317.99
Museum or Cabinet		1239.27
Publication and Printing	$843.05	
Less receipts on this account	337.83	
		505.22
Salaries and Wages		5974.17
Repairs of Building and Cases		163.30
Fuel		299.69
Gas		111.15
General Expenses		749.47
Insurance for five years		755.39
Laboratory		380.73
Balance		835.90
		$11,332.28
Teachers' School of Science—		
Expenses to date of Course of Lectures now being given in Huntington Hall		2065.73
Balance on hand unexpended		216.79
		$2282.52

CHAS. W. SCUDDER,
Treasurer.

Boston, May 1, 1879.

The annual reports were accepted. The election of officers for the year was then ordered, and Messrs. Van Vleck and Greenleaf being requested to collect and count the ballots, declared the following gentlemen elected:

PRESIDENT,
THOMAS T. BOUVÉ.

VICE-PRESIDENTS,
SAMUEL H. SCUDDER, JOHN CUMMINGS.

CUSTODIAN,
ALPHEUS HYATT.

HONORARY SECRETARY,
S. L. ABBOT, M.D.

SECRETARY,
EDWARD BURGESS.

TREASURER,
CHARLES W. SCUDDER.

LIBRARIAN,
EDWARD BURGESS.

COMMITTEES ON DEPARTMENTS.

Minerals.

Thomas T. Bouvè,
R. H. Richards,
M. E. Wadsworth.

Geology.

L. S. Burbank,
Wm. H. Niles,
Rev. G. Fred. Wright.

Palæontology.

Thos. T. Bouvé,
N. S. Shaler.

Botany.

John Cummings,
Charles J. Sprague,
J. Amory Lowell.

Microscopy.

Samuel Wells,
R. C. Greenleaf
B. Joy Jeffries, M.D.

Comparative Anatomy.

Thomas Dwight, M.D.,
J. C. White, M.D.
W. F. Whitney, M.D.

Radiates, Crustaceans and Worms.

H. A. Hagen, M.D.,
Alexander Agassiz,
L. F de Pourtalés.

Mollusks.

Edward S. Morse,
J. Henry Blake,
C. O. Whitman.

Insects.

S. H. Scudder,
Edward Burgess,
A. S. Packard, Jr., M.D.

Fishes and Reptiles.

F. W. Putnam,
Theodore Lyman,
S. W. Garman.

Birds.

Thomas M. Brewer, M.D.,
Samuel Cabot, M.D.,
J. A. Allen.

Mammals.

J. A. Allen,
E. L. Mark.

Messrs. D. W. Jones and Charles G. White were elected Associate Members.

Mr. M. E. Wadsworth read an essay on the classification of rocks (to be published by the Museum of Comparative Zoology).

The following papers were read by title: Palaeozoic Cockroaches, by S. H. Scudder (to be printed in the Society's Memoirs), and

SOME ADDITIONAL NOTES UPON BIRDS OBSERVED IN NEW ENGLAND, WITH THE NAMES OF FIVE SPECIES NOT INCLUDED IN HIS PREVIOUS LISTS OF NEW ENGLAND BIRDS. BY T. M. BREWER.

Early in February, 1878, I read a paper giving some brief notes on certain species of New England birds, and enumerated twenty-one, in addition to those previously given in 1875, as entitled to a place in a catalogue of the Birds of New England. The occurrence of these had been ascertained by different parties during the interval of not quite three years. During the fifteen months that have since elapsed five additional species have been noted, some rare or doubtful ones reaffirmed, and several very interesting discoveries have been made in regard to the history of the movements and distribution of other kinds. One of the most surprising and remarkable of these has been the discovery of quite a large colony of the Loggerhead Shrike, hitherto regarded as an extreme southern species, breeding about Bangor, Me., and a smaller colony of the same bird at Rutland, Vermont.

Mimus polyglottus Boie. The occurrence of the mocking-bird in various parts of southern New England, is a matter of general tradition, but is not so common that it is uninteresting to preserve a careful record of such cases as arise or have been noted. On the 8th of October, 1878, Mr. George H. Mackay shot a fine young male in Nantucket. It had evidently never been a caged bird, and was in excellent condition. In the Society's collection is also a female mocking-bird taken by the late F. P. Atkinson. Although the locality is not given it was probably taken in some part of Massachusetts, as are supposed to be all Mr. Atkinson's examples not otherwise marked.[1]

Regulus satrapa Licht. The long desired nest and eggs of the Golden-crowned Kinglet have, at last, been discovered. They were taken near Bangor, Maine, by Mr. Harry Merrill of that city. The nest was in a fir tree, some ten feet from the ground, globular in shape, semi-pensile in position, and contained ten eggs (Bull. Nutt. Orn. Club, IV, 96).

Polioptila caerulea Sclat. I referred, in my previous paper, to a single specimen of the Blue-gray Gnatcatcher, shot in Chatham, Mass. Since then our New England collection has been enriched by a second specimen, procured by Mr. F. J. C. Swift of Falmouth, Mass., in that town, December 18, 1877. It was among some low bushes, on the borders of a fresh-water pond. Although taken in December, the weather was not severe at the time, as was shown by the absence of ice from the pond.[2]

Certhia americana Bonap. A pair of the common Gray Creepers was found nesting near Taunton on the 27th of May, 1878, by Mr. Charles T. Snow. The nest was between the trunk and the bark of a dead pitch-pine tree, and contained young just ready to fly when found. This is the most southern record that we have of the breeding of this species.

Thryothorous ludovicianus Bonap. The Great Carolina Wren has been long looked upon as one of the birds that "ought to be found" in New England, and although we have been told that certain parties thought they saw it and recognized its note, the example itself had never been forthcoming. On the 6th of July, 1878, one of these birds, a fine specimen as it proved, ventured into the garden of Mr. Geo. O. Welch, taxidermist of Lynn, and its strange note soon drew attention to the little stranger. The consequences of such imprudence were the securing for our New England collection of the first specimen known to have been taken within the limits of these States. Since then Mr. Purdie mentions (Bull. Nutt. Club, IV, p. 61), the capture of another by Mr. J. H. Clark, at Saybrook, Conn., Nov. 25, 1878.

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[1] Since the above was written, Mr. A. J. Lewis, of Columbus Square, Boston, informs me that on the 7th of December, 1878, he captured near Egleston Square a male example of this species. It was in an open field, feeding on some berries, was in good condition, and is supposed not to have been a caged bird — a supposition which, however, the season of the year in which it was taken does not favor.

[2] Just as this paper is going to press, (Oct. 24th), my young friend Arthur P. Chadbourne writes me that on the 26th of Sept., 1879, at Osterville, Cape Cod, he captured an adult female example of *Polioptila caerulea*. This, so far as I am aware, is the third example known to have been taken in New England. Mr. Chadbourne has kindly supplied me with the following memoranda:

Length, 4.75 in.; stretch, 6.12; wing, 2.55; tail, 1.90; tarsus, .57; eyes, black; upper mandible, brown; lower mandible, light brown; feet, black; contents of stomach, insects and larvae. He also states that it was found in a wild cherry tree about 15 feet high, was in company with Pine Warblers and Chipping Sparrows, which, however, it attacked and drove away when they came too near. It was very tame, and remained undisturbed when his near approach frightened the other birds away.

Anthus ludovicianus Licht. Mr. W. A. Jeffries shot, on the 8th of June, 1878, a fine example of this species. Its mate, if it had one, was not noted, and by it no means follows that it would have bred in that locality, but its occurrence so late in the season is certainly an interesting and suggestive fact, establishing its eccentric and irregular habits. The species breeds both in Colorado and in high northern regions, and appears to be liable to occur here almost every month in the year.

Helminthophaga pinus Baird. It seems after all, that this species has also a good Massachusetts record. Attention was called (Bulletin III, p. 188), to an example of this species in the collection of this Society procured in Dedham, several years ago, and mention is made of another shot in West Roxbury by Mr. C. N. Hammond, May 17, 1878. It is not given as of Massachusetts, in my catalogue, and, though given in Mr. Allen's first list of the birds of Massachusetts, is not mentioned by him in his latest catalogue, except as a bird of probable occurrence.[1]

Dendroica dominica Baird. In the Bulletin of the Nuttall Club (III, p. 146), is noted the capture, some ten years ago, of the Yellow-throated Warbler on the banks of Charles River, by Mr. Geo. E. Brown, of Dedham. This is the first recorded instance of its capture in Massachusetts, and its second New England record.

Dendroica pinus Baird. Mr. N. C. Brown in the Bulletin for April, 1879, furnishes some very interesting notes on the distribution of this bird in the southern portion of Maine, showing also that I overlooked in Prof. Verrill's second list his mention of it, as a bird of Maine. It is now said to be an abundant summer resident in the vicinity of Portland, to be common near Brunswick, and even to reach Calais, though it was not given by Mr. Boardman in his list of the birds of that vicinity. It is not known to occur far to the north in the western part of that State.

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[1] Since the above was in type Mr. Harry Merrill of Bangor informs me that Mr. N. A. Eddy of that city has found the Blue-winged Yellow Warbler (*Helminthophaga pinus*) breeding near New Haven. The nest was found June 14th; on the 20th it contained four eggs, and with the ♀ parent was then taken. The nest was on the ground, and was loosely constructed of oak leaves. This is, I believe, the only instance in which its nest has been recorded as taken in New England.

Stelgidopteryx serripennis Aud. In my former paper I referred to a single specimen as furnishing grounds for placing the Rough-winged Swallow among the birds of New England. Mr. J. A. Stannis of Hartford (Bulletin IV, p. 112), shows conclusively that this species breeds regularly in that State. He found it nesting at Green's Farms, west of New Haven, on the New York and New Haven Railroad, in old stone abutments. Though thirty trains a day passed within a few feet of their nests, it did not apparently disturb them in the least.

Collyrio ludovicianus Baird. One of the most interesting and certainly the least anticipated of the discoveries of the year, has been the finding of Loggerhead Shrike, — a supposed exclusively southern species, — breeding in the central portions of Maine and Vermont. In the ninth volume of the Pacific Railroad Report, the bird is given, by Prof. Baird, as having its habitat in "the South Atlantic and Gulf States." And throughout the extended interval of territory between the southern region, where it is abundant, and these isolated New England colonies, it is very rarely known to occur. Its presence in New England was first publicly noted by Mr. H. A. Purdie in 1873, and in 1875 it was included in my catalogue of New England birds. Since then many other instances of its occurrence have been noted. In the summer of 1878 I received from Mr. H. E. Boughton, what was represented to me as a set of the eggs of *Collyrio borealis*, from Rutland, Vermont, and a single egg said to belong to a bird of the same species (though neither proved to be *borealis*), from Mr. Jenness Richardson, also of Rutland, and who regarded the egg as that of *C. borealis.* Accepting these eggs as genuine, I prepared to look up all the evidences of the supposed instances of the breeding of the Great Northern Shrike within the limits of the United States, and Mr. S. L. Willard of Utica, N. Y., kindly supplied me with the data of a number of instances contributed by various writers to the Oologist. Among these was the account of a nest found by Mr. C. A. Morse of Bangor, May 5, 1877. Most fortunately, as it proved, my information in regard to this nest was so meagre that I wrote to a much valued correspondent[1] in Bangor, requesting him to supply me with the desired data. Happily the parent bird of this nest was in existence, and was at once kindly forwarded to me. It proved to be, not *C. borealis*; but, unexpectedly, *C. ludovicianus*, and my correspondent informed me that while the Loggerhead was far from being uncommon, *C. borealis* was neither known to breed nor to be present during the summer, in that neighborhood. This was a most unexpected revelation, and it at once prompted me to ascertain with certainty, if possible, what species of shrike it was that had been nesting in and about Castleton and Rutland, Vermont. The result was as I anticipated. Mr. Richardson, who had acted in good faith, sent me his parent bird, and this, too, proved to be *C. ludovicianus*, and such undoubtedly have been all the shrike's nests found in that neighborhood, as well as all those near Bangor.

In regard to the nests of the supposed Northern Shrikes, found in the vicinity of Utica and Oswego, I have, as yet, been able to procure ample evidence in only a single instance; this has been in regard to a nest with eggs found at Oswego, New York, and in this the parent bird was actually *borealis*. This is the second recorded instance, as far as I now know, where there is positive evidence of *C. borealis* breeding within the limits of the United States.[2]

As the occurrence of what has hitherto been taken for granted to be an extreme southern species, in so many instances, and, moreover, breeding so freely in Northern New England, is a matter of more than common interest, I will give in this connection the data kindly furnished me by Mr. Richardson of Rutland, and Mr. Harry Merrill of Bangor.

Mr. Richardson has supplied me with some very interesting notes in regard to four nests of *C. ludovicianus* taken in his neighborhood. One of these nests found in 1876, was near the town of Castleton, a town lying just west of Rutland, Vt. The first, found April 28th, by a lad in Mr. Richardson's employ, contained two eggs, one of which was taken. Three days later Mr. Richardson visited the nest, which was built in an old orchard of fruit trees, intermingled with a few maples and thorn bushes, and was situated just back of a farmhouse. The nest was placed on a horizontal branch of an apple tree, among three or four off-shoots from the limb, and was just nine feet eight inches from the ground. On his approaching their nest the birds flew about his head, making quite a distinct and peculiar snapping noise with their bills. Occasionally they alighted quite near him, fluttering their wings and repeating the same singular, snapping sounds. In all his experience, even with hawks, whose nests were being robbed, he had never before met with so resolute a resistance from any parent birds. The nest had been found on the first of May, to contain three eggs, which were left, and on the 6th two more had been added, or six in the entire set. This time the nest and eggs were taken, and parent (♂) bird secured. The nest was composed externally of dry grasses and vegetable stalks, intermingled with the blossoms of the Indian Tobacco and white feathers from the neighboring poultry yard. There were also bits of wood and cotton and fragments of cotton twine. The inside of the nest was neatly lined with horse hair, nearly all of which was also white. It had an external diameter of seven inches at the top, a depth of three, and the cavity was two inches deep.

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[1] Mr. Harry Merrill.

[2] Since the above was in type Mr. D. D. Stone of Oswego, my informant, writes me that no example of *borealis* has been observed in that neighborhood in the season of 1879. The parent of a nest secured by him and which he has sent me, is pronounced by Mr. Ridgway to be a typical *ludovicianus*. It is perhaps too soon to decide in regard to the presence or absence of *borealis* in the breeding season within the United States, but the more the subject is examined the more conclusive appears to be the evidence that there are no data in support of certain opinions so positively pronounced, on the affirmative side.

The second Rutland nest was taken by another person, and in regard to this I have no notes. One of its five eggs is in my cabinet. The female parent of the first mentioned Rutland nest found another mate, with whom she re-appeared on the 8th of May, and the pair, very unwisely, built their new nest in the immediate neighborhood of the first, and in a similar tree. On the 13th two eggs were found and taken, and it was ascertained that three others had been taken by some one else. Four of these eggs are also in my collection. Mr. Richardson regards the shrike as quite unusual in that region in the summer, while *C. borealis* is only found in the winter.

Mr. Harry Merrill, of Bangor, Me., has laid me under great obligations by the thorough manner in which he has investigated all the facts, so far as they could now be traced, of the occurrence of the Loggerhead in the neighborhood of that city. In a letter dated Jan. 27, 1879, he wrote me substantially that "All the evidence is *entirely adverse* to the assertion that *C. borealis* has been found breeding here. I have repeatedly heard of the finding of their nests, but upon following out my inquiries I have not found a *single authentic instance*. The persons who made these reports did so in all honesty and good faith, but their identification of the bird was very imperfect. One person, in answer to an inquiry as to how he had identified the bird, said he knew it because of its resemblance to the picture in Samuels's 'Birds of New England,' and, as that book is authority on all ornithological matters, the existence of any other shrike was perhaps not known. The truth is, that every identified nest proved to be that of *C. ludovicianus*; and since these birds have never been recorded as breeding in New England, a few notes from this quarter may prove of interest. Since you mentioned Mr. C. A. Morse's case, I gave special attention to it, and procured the skin of the bird from Mr. Brown, who was with him when the nest was found. This skin I send to you as a proof of the bird's identity. The following is the result of my inquiries and observations: During the last two years, six nests have been discovered in the immediate vicinity of Bangor; two were in apple and four in fir-trees — all in rather open fields — and they varied in height from four to ten feet above the ground; five were placed on horizontal limbs; all, with one exception, contained eggs — four contained six each, the fifth contained three (the last set evidently not complete); the eggs varied in size from 1.07×.72 to .87×.72, the former being the usual size. The nests were procured in May; all were composed of sticks and lined with feathers; one had everlasting mixed with it. These nests were in some cases very near the travelled road, and none were far from civilization. Some six or seven birds have been shot, and *none* were Great Northern Shrikes. One of the birds in my collection showed the following dimensions when fresh: length, 8.38; stretch of wing, 10.75; wing, 3.76; collected Aug. 23, 1878. The birds in some cases flew around the intruders within a few feet of their heads, and in one instance the old bird remained on the nest till it was nearly touched by the hand. Two of the six mentioned nests were procured without the birds, but the person who found them is certain that the birds were like the others. One of these[1] nests is in the possession of Mr. C. J. Maynard, and is labelled as *C. borealis.* I feel warranted in saying that there is no authentic specimen of the egg of *C. borealis* in any collection in this city which purports to have been found here." In another letter dated March 8, Mr. Merrill informs me that he has examined two more shrikes' skins, both similar to those already examined — one obtained with nest and eggs, the other with young.

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[1] This nest was referred to in Forest and Stream, April 3, 1878, as a genuine nest of *borealis*, but subsequently the error was admitted and corrected. But for the prompt and thorough investigations of Mr. Merrill here would have been a false record made which it would have been impossible to set right, and this is a case in point, showing how easy it is unintentionally to be led into error, and

Aegiothus canescens Cabanis. In my catalogue of the Birds of New England I gave this species (or variety) as a winter visitant in eastern Maine, on well established facts given me by Mr. Geo. A. Boardman. Notwithstanding its unquestionable authenticity as a bird of north-eastern New England, a writer saw fit to place its right to be so considered as on a par with that of four or five species having no New England record. Later observations enable me to extend my first record and to bring this form nearer home, making it include Massachusetts as well as Maine. Mr. Wm. A. Jeffries shot one of this form on the 16th of November, while collecting in Swampscott, and in the collection of skins made by the late Mr. F. P. Atkinson is another skin of *canescens* = *exilipes*, which is undoubtedly referable also to Massachusetts, where, as before stated, all of Mr. Atkinson's examples not otherwise marked are presumed to have been taken.

Passerculus savanna Bonap. I refer to this very common species merely to mention its abundant occurrence, breeding in considerable numbers within a few rods of one of the most thronged thoroughfares of Boston—West Chester Park. Quite a number of its nests were found by Mr. C. A. Hawes on the sides of the Boston & Albany Railroad, just west of the avenue in question, and he has presented the Society with the parent bird and a set of its eggs.

Passerculus princeps Maynard. Without raising the question of race or species in regard to this well marked form, it is worthy of mention that during the fall and winter of 1878–9 the Messrs. Jeffries have procured quite a number of this somewhat rare

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how difficult it often is to test and correct that error when once recorded. There is no reason, whatever, for supposing that *borealis* is present in summer near Bangor, while the experience of 1879 added to that of 1877 and 1878 demonstrates *ludovicianus* to be a not uncommon summer resident.

variety.[1] The first one was taken Oct. 26, when a number were noticed. Between then and Dec. 1, eleven were taken. Mr. Jeffries infers that this species is a late fall migrant, only a few spending the winter here. It arrives in force during the first week in November, when *P. savanna* are fast disappearing. Mr. Jeffries regards it as a northern race of *P. savanna*. Mr. John A. Jeffries has added an example to our New England collection.

Crythagra butryacea Linn. I do not mention the name of this South African species because I believe it entitled to a place in my catalogue. I regard its presence in midwinter on the bleak seacoast of Massachusetts as wholly and purely accidental, and not likely to be repeated. It was shot early in February, 1879, at South Scituate, by Mr. Willie Borland, and when taken had all the appearance of a wild bird. Its plumage was clean and fresh, and the bird was in good condition. Undoubtedly it had once been a caged bird, but this must have been some time since, long enough to have enabled it to assume a new unsoiled plumage, and to demonstrate its ability to take care of itself during one of our severest winters.

Chrysomitris elegans Linn. This species stands in a very similar position to the preceding. It is a common bird of Europe, and is not known to occur in this country. Its abundance as a caged bird may eventually lead to its introduction as a resident species, but I am not aware that such is at present the case. This individual was shot near this city in the spring of 1878 by Mr. C. F. Rice, but I do not regard it as entitled to a place in our catalogue of recognized New England species. When taken it was in company with a flock of the common American goldfinch.

Nyctale Richardsoni Bonap. This owl is generally regarded as a rare visitant to New England. Certainly there are so few records of its appearance that I feel justified in mentioning two recent instances. Mr. Harry Merrill, writing February 14, 1879, informed me that he had recently procured an example of this species in the neighborhood of Bangor. It was kept alive for some time, and Mr. Merrill was interested to learn that Mr. Audubon procured the only living species that he had ever seen of this species, in Bangor in 1832. And Feb. 26, 1879, Mr. Outram Bangs procured a female example near Newton, Mass.

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[1] In the May (1879) number of Lippincott, Mr. N. C. Brown contributes some very interesting notes on Beach-birds, in which he mentions meeting with several of this species in October, 1876, as they were running on the open sand in a depression between two hillocks. They were loath to take wing, but ran and dodged in the grass, like the Savannah Sparrow. In all, he writes me, he had secured ten examples.

Florida caerulea Baird. The occurrence of the Small Blue Heron in New England is not so frequent as to render it undesirable to establish every authentic record of its presence. The Society during the last year has come into possession of an example of this species, in the immature plumage. It was shot at Cohasset about ten years since by Henry D. Morse, Esq., and has been by him added to our New England collection.

Nyctiardea violacea Baird. Mr. Wm. Brewster records in the April (1879) Bulletin the second capture of a Yellow-crowned Heron within the State of Massachusetts. It was taken on the 30th of July, 1878, in a densely populated part of Somerville. The example was in immature plumage and apparently very young. The examples of the wandering disposition of this species are somewhat noteworthy. Specimens have been taken in the mountains of Colorado, and on the plains of Kansas. In one case in the last named State the female parent was accompanied by her three young, hardly able to fly. Yet it is not known to breed anywhere in that neighborhood.

Ibis falcinellus. Early in May, 1878, quite a number of this species, so infrequent in New England, was taken in various places on Cape Cod. (Bull. Nutt. Club, III, 151, 152). Mr. Frank L. Tileston informs me that in the following August several specimens of what were called black curlews were noticed on Prince Edward Island; one of them was shot by a gentleman of Boston but was not preserved. Although inconclusive this evidence seems to indicate the presence of this specimen in a locality north of the United States.

Recurvirostra americana Gm. Mr. N. C. Brown mentions (Bull. Nutt. Club, IV, p. 108) several instances in which the Avocet has been known to occur in Maine, one was near Cape Elizabeth, Nov. 5th, 1878, but this is the only instance that can be traced to an authentic source.

Macrorhamphus scolopaceus Lawrence. A beautiful example of this form,— be it race or species,— was shot by Mr. Frank L. Tileston, and is now in the Museum of the Boston Nat. Hist. Society. It was procured at Eastham, Nov. 2, 1878. It was in the plumage, with the elongate bill, etc., so eminently typical of this form

Micropalama himantopus Baird. The past year has brought with it no new fact of any moment, bearing upon the history of this bird, certainly nothing to establish any regularity as a migrant on the New England coast, nor indeed on any part of the Atlantic coast.

Throughout Nova Scotia, New Brunswick, and the entire coast of Maine as far west as Portland, it has remained wholly unknown. From Scarboro', Me., to Rye, N. H., we have no record of its having been taken; and from Swampscott, along the entire coast of Massachusetts to Provincetown it continues equally unknown. During the past summer the only record that has reached me of its occurrence was a single specimen procured by Mr. Geo. H. Mackay at Nantucket, July 25, 1878. This is the second example taken in July in Massachusetts. So far as negative testimony can ever be taken as conclusive, the absence of any data in regard to the presence of this species in any very considerable numbers on the New England coast continues to suggest that its regularity as a migrant is still, and more than ever, a thing not proven.[1]

Limosa hudsonica Sw. An adult female specimen of the Hudsonian Godwit was procured by Mr. Frank L. Tileston at Eastham, as late as November 2, 1878. It was in fine condition.

Gallinula galeata Bon. The Florida Gallinule is not a bird of very rare occurrence in New England, yet mention of its being met with is not without interest. We have added to our collection, through Mr. Geo. H. Mackay, a specimen taken on Nantucket some three years since. And on the 10th of September, 1878, Mr. Edward O. Bangs procured a female example in Wayland.

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[1] In the vicinity of Portland, Me., from Scarboro' to the islands in Casco Bay as I have already stated, two or three instances of its occurrence have been given me by Mr. Morse. I have recently been informed by Mr. N. C. Brown of the following captures, which I compile from memoranda kindly given me by that gentleman:

One shot on Little River Marsh, Scarboro', some ten or twelve years since, and examined by Samuel Hanson, Esq., of Portland. The exact date lost.

One shot in Scarboro', Aug. 12, 1872, by Alpheus C. Rogers, Esq., of Portland.

One taken at Chebeague Island, in Casco Bay, July 19, 1875, by Mr. J. H. Bond.

August 14, 1875, a solitary female was taken by Mr. Brown in a small marsh on Cape Elizabeth.

August 24, 1877, Mr. Brown shot an example from a large flock of *Gambetta flavipes*, on Scarboro' Marsh.

Sept. 16, 1878, another example was taken by Mr. Brown in Scarboro', and is now in his collection.

Mr. Brown refers to Everett Smith, Esq., of Portland, as having taken

Rallus elegans Aud. Mr. Purdie (Bull. Nutt. Club, III, p. 146), mentions the capture of an example of the King Rail on the Sudbury meadows, by Mr. Geo. E. Browne of Dedham, several years since.

Rallus crepitans Gm. Mr. N. C. Brown (*ibid* IV, p. 106), in an interesting paper on birds occurring near Portland, mentions the Clapper Rail as a rare visitor to Maine, on the ground of several specimens procured in Falmouth, Oct. 17, 1866.

Cygnus americanus Sharpless. In the same journal (III, p. 198), Mr. Brewster refers to a fine specimen of the Whistling Swan in the possession of Mr. H. S. Sweet of Nantucket. It was shot March 4, 1878, on Coskata Pond by Mr. F. P. Chadwick. In the Bulletin for April, 1879, Mr. Brewster mentions another swan killed at Seabrook, N. H., Oct. 18, 1878. It was a male in immature plumage.

In the collection of our Society is another specimen of this swan, the history of which has, unfortunately, been allowed to become obsecured by an omission to record the data of its capture. From information, however, received from Mr. Geo. O. Welch, I have no doubt that it was shot some fifteen years ago at Nahant by a Mr. Taylor. It was for some time on exhibition in the house of Mr. Tudor, and was finally purchased by Deming Jarvis, Esq., and by him given to our Society. It is entitled, on the evidence, to a place in our New England collection.

Anser hyperboreus Pallas. All notes touching the occurrence of this species in New England are of interest. Mr. Purdie is authority (Bull. Nutt. Club, III, p. 146), for the capture of one off

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about eighteen examples of that bird in that neighborhood, from whom I hope to receive further particulars as to the circumstances under which these were taken.

Rye, N. H., Ipswich, Salem, and Swampscott, Mass., are the only places in which the occurrence of this species is recorded in all eastern New England, and there the numbers have been small and the occurrence irregular. From Swampscott to Provincetown, along our eastern coast, absolutely none are recorded. From Provincetown to Bristol County the number is one solitary individual, and that without complete certainty; Nantucket, one individual; Elizabeth Islands two single cases; the rest of Massachusetts, none; Connecticut, none; Rhode Island, none: Long Island, north shore, none; south shore, found in a very restricted portion, and in one instance in considerable numbers. And here I may mention that Giraud, author of The Birds of Long Island, a noted sportsman and excellent ornithologist, who made Long Island the field of his researches, met with but *two individuals of this species in the course of his life.* From Long Island to Squam Beach in New Jersey, we have no record, and on the last named ten are mentioned, all but three single cases.

Scituate in November, 1877, by Mr. Geo. E. Browne of Dedham, and now in the collection of that gentleman.

Fulmarus glacialis Steph. In my catalogue this species was given in my challenged list as referred to our coast but without any known fact to corroborate this opinion. It must now, however, take its place among our birds, though how common it may be remains to be ascertained. Early in November last I saw a living specimen of this bird in the yard of Mr. Geo. O. Welch, to whom it had been sent for mounting, and I subsequently learned from Mr. Milner, Prof. Baird's assistant, that it had been taken by Capt. Wm. Sweet of the fishing schooner Grace C. Hadley, Oct. 28, 1878, by a cod-hook on the eastern part of George's Bank.

Stercorarius catarractes Temm. The interesting capture of one of this species last summer on the Georges Banks, its subsequent preservation by Prof. Baird, who secured it as an example for the National Museum, are matters of record, and entitle the Fulmar Petrel to a place among the Birds of New England. Mr. R. L. Newcomb, who under the directions of Prof. Baird, spent three weeks on the Banks, mentions in his published note, seeing another of this species, but how many or if there were more than one is not stated.

In this connection a mere mention of the sea-going species secured by Mr. Newcomb for the Smithsonian collection will not be out of place.

Puffinus major Fisher.[1] Greater Shearwater; *P. fuliginosus* Strick. Sooty Shearwater. *Stercorarius pomatorhinus*; *S. crepidatus*; *S. parasiticus*; *Sulla bassana.*

Xema Sabini Bon. The occurrence of Sabine's Gull on the New England coast is so rarely mentioned that all instances are worthy of record whenever noted. In June 1878, I received a letter from Mr. George A. Boardman of Milltown, N. B., dated June 15th, from which I make the following extract: "I was lucky enough to get a nice Sabine Gull a few weeks ago. I have known this bird to be about almost every Spring, but was never before able to get one, and only succeeded by getting a cart-load, almost, of Bonaparte gulls. As you go from Eastport to Calais, you can often see with a good glass a gull or two among the thousands, with the back wing feathers, different from the Bonapartes. My bird is nearly in full plumage, and I was glad to get so good a skin to mount."

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[1] Mr. Newcomb in his notes (Bull. Nutt. Club, IV., 126), refers to having seen several specimens of *Puffinus anglorum*. As there is no record of the occurrence of this species on this coast, and as it is with difficulty distinguished from *P. major*, which is abundant on the Banks, it is quite probable that he was mistaken. I do not feel justified in including it until one has actually been taken.

Sterna fuliginosa Gm. Another very interesting and unlooked for occurrence that has been brought to my notice, was the capture, in 1876, of two examples of the Sooty Tern in northwestern Vermont. For the knowledge of this erratic performance on the part of this intertropical bird I am indebted to Mr. Jenness Richardson, of Rutland, Vt., who also kindly sent me both examples to examine, and has consented to allow one of them to remain in the Society's New England collection. The New England record of this wanderer, that breeds almost exclusively within the tropics, is somewhat peculiar. It is first named by Mr. J. A. Allen on the authority of Mr. Samuels as breeding on Muskeget; but, satisfied that he had been grossly misinformed on this point, Mr. Samuels withheld it from his own work on New England birds. In a list of the birds of New England, published in 1868, the Sooty Tern again appears, but only on authority believed to be incorrect. In 1875, finding no single known instance on record of its occurrence, and Mr. Lawrence writing me that it was not known to occur even on the coast of New Jersey, I had no alternative but to give it in my list of birds claimed as of New England without any tangible evidence. Since then, Sooty Terns have appeared in at least five of the New England States, and in interior regions as far from the seaboard as Cayuga County, N. Y. The two sent me from Vermont were taken at different periods of the same season. One was captured on Lake Champlain early in September. This one was in the full adult plumage. The other was shot in the streets of Rutland in the midst of a violent storm, and was in its immature dress. The latter has been obtained by exchange, and is now in the Society's New England collection.

Hydrochelidon nigra Linn. Instances of the occurrence of the Black Tern on the New England coast are rare. On August 8th, 1877, Mr. George H. Mackay procured an immature specimen at Hummock Pond, Nantucket, and subsequently Mr. William Brewster has obtained other specimens on the same island. We are indebted to each of these gentlemen for an example. So far as I am aware, specimens of this Tern taken in New England have been birds in immature plumage.

Sula fiber Linn. All doubts as to the right of this species to take a place among the birds not only of New England, but of Massachusetts also, must now yield to a fine example in the collection of Messrs. E. A. and O. Bangs of Boston. It is a male specimen ; was shot on Cape Cod, and brought to the Boston market Sept. 17, 1878, where my friends purchased it. Though the particulars of the exact time, place, and parties by whom it was procured are not obtainable, I have no reason to doubt that it was actually taken within our State limits. Of the two previous instances cited, in one case there was no record preserved, and in the other the alleged example proved to be an immature *S. bassana.*

Assuming as entitled to a place in the catalogue of the birds of New England all the forms given Feb. 6, 1878, the five [1] additional species here named would swell our list to three hundred and sixty-one. But the same reasons for not including *Crythagra butyracea* and *Carduelis elegans* in our list should lead us to exclude *Thaumatias Linnaei.* And it is very doubtful how far we are justifiable in retaining in the list quite a number of stragglers, whose presence, in a single instance, may have been entirely fortuitous, and not liable to occur a second time. Such unlooked-for visits as those of the Louisiana Tanager, in mid-winter, of the Sooty Tern and the Booby Gannet are events as full of interest as they are inexplicable. Their record should be carefully preserved, and, in the future, we may have the means to better understand what at present puzzles and confounds us. That birds cited as exclusively "inter-tropical" during their breeding season, and " oceanic " at other times, should be found in October on our inland lakes is hardly more surprising than that another bird mentioned as confined to the " South Atlantic States," and not known to occur except as a straggler from North Carolina to New England, should be found breeding in numbers in two of our most northern States.

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[1] NOTE.—Just as this paper was about to be printed, Prof. Baird writes me that an immature specimen of the *Rhynchops nigra* (Black Skimmer) was shot by Mr. John F. Carlton, of Wood's Holl, near that place, and Mr. George A. Boardman, of St. Stephen, N. B., informs me that several examples have been taken off the coast of Maine the present season. This adds another species, making the fifth addition to the New England list, and the present number three hundred and sixty.

NOTES ON THE SUBMARINE COAST-SHELF, OR HUNDRED FATHOM DETRITAL FRINGE. BY N. S. SHALER.

I have been for sometime engaged in an inquiry into the nature, distribution and effects of the one hundred fathom detrital fringe which borders all the tide-swept shores of the North Atlantic, and probably those of other oceans. A thoroughgoing inquiry into the history of this singular structure presents so many difficulties, that it may be many years before I find myself in a position to come to any final conclusions concerning its problems, and therefore, venture to give a brief synopsis of the conclusions to which I find myself drawn by the evidence now in my possession.

In the first place it is to be noted that this deposit, which I shall for convenience, term the coast-shelf, exists along the whole coast of the North Atlantic Ocean, and that while it differs very much indeed in width, and consequently in mass as well, its slopes show a singular likeness in all the sections. In the next place we should notice, that this shelf has been formed with a very great uniformity along shores which have had a very great diversity in their history, and exists along shores which have recently been subjected to great elevations, as well as along others which have been for a long time nearly stationary, and also along yet other shores which have been undergoing considerable subsidence in the last geological period. For instance, on the North American Atlantic sea-coast we find it about the Labrador coast where the shore has very recently been subjected to an elevation of over one hundred fathoms, again on the coast near Cape Hatteras, where the change in the same time has been very little, and yet again off the South Carolina coast, we have the same fringe of detrital matter, though that region has recently subsided a good deal.

From such facts we are driven to the conclusion that this shelf is rapidly formed, and that it may be accumulated in either of the three conditions of upheaval, subsidence, or immobility of the shore. I am inclined to the opinion, however, that while the shelf may be formed in either of these three diverse conditions, its formation is much favored by the first of these, *i. e.*, the process of upheaval.

The next most important fact connected with this deposit, is its apparent absence or change of character along the shores of the tideless seas. So far I have been unable to find any distinct indication of the existence of a precisely similar shelf along the shores of the Mediterranean Sea, or the great inland lakes of this continent. Along all tideless shores there is generally a fringe of detrital matter extending out a certain distance from the coast. This shelf in tideless seas differs from that we find along tide-swept shores in certain important ways. It is much less wide, and has its outer edge in very much shallower water.

If I am right in my observations this difference between the detrital shelf in tideless and tidal seas, is due to the action of the tidal currents which are active along the shores of the ocean. It is a well known fact that the vigor of the movement of the tides diminishes with the increase in the depth of the water, and at one hundred fathoms the power of the tidal currents must be very small. There is but one force working along the shores of the tideless seas, competent to convey detritus seaward, the force of the under-tow arising from the current driven against the shore by the winds, while along the shores of the open seas this current, in itself stronger by virtue of the heavier waves, is aided by the tidal action which is probably much more effective than the wave-current in transporting substances at considerable depths. While it is to the waves that we must look for the effective work of breaking down the shores of the sea, and grinding up the detritus, it is to the tides that we mostly owe the transporting and sorting of this sediment over the detrital plane of the coast-shelf.

The action of tidal and undertow currents in removing sedimentary matter seaward is doubtless materially aided by the motion of the waves; even at a depth of one hundred fathoms the vertical oscillation of the waves would be sufficient to disturb fine silt and put it in the control of the currents produced by the tides and the undertow.

When the sea is gaining on the land, this shelf is generally less distinctly determined than when the land is rising; the process of elevation is very favorable to the rapid building of a well-marked detrital shelf, for, while it is going on, the sea obtains control of much more detrital matters than when the shore is stationary or subsiding. I do not care at present, to discuss the history of this interesting accumulation of ditritus; that cannot be effectively done without the use of more data than can be furnished in this paper; it will be worth while, however, to consider some of the geological consequences arising from the rapid movements of these great masses of detrital material stored in the coast fringes of our ocean shores, — movements brought about by the changes in the level of the lands.

It is quite certain that the method of formation which we see now in the detrital shelves of our shores is the usual way in which the coarser detritus of geological formations is accumulated — all our sands and gravels, as well as the larger part of the coarser muds, are necessarily laid down close to the shore line within the range of currents strong enough to carry them, so that the first place of deposition of the mechanical sediments is in this coast shelf — their further history depends upon the changes of position in the region where they are deposited.

If any shore line along which a detrital shelf has accumulated is subjected to a rapid subsidence, the deposit will be buried beneath strata of another character. It will then, on subsequent elevation, appear to us as a strip of coarse, irregularly disposed sediments thinning out towards either edge, and having its greatest extension in the trend of the old shore line. The direction of the ancient shore will be indicated by the position of the coarser materials, which will generally prevail on the shoreward side of the mass. If, on the other hand, the shore line rises with considerable rapidity, the detrital mass will be worn on its landward, and rapidly accumulated on its seaward, border. Generally, however, the wearing action of the sea is not sufficient to take away the whole of the detrital mass with it in its retreat; a part remains, and is elevated above the water level. Thus the result of elevation is to disperse the matter composing the detrital shelf over a wide surface.

I am inclined to believe that many of the sudden invasions of coarse sediments into what had hitherto been areas of pretty deep sea, may be accounted for by supposing that a process of elevation had brought about the removal seaward of great masses of detritus which, during the periods of greater stability, had been accumulating along the neighboring shores. My attention was first called to the questions discussed in this paper, by the difficulty of accounting for the rapid deposition, and peculiar distribution of the carboniferous conglomerate or millstone grit within the Commonwealth of Kentucky. There we have a deposit of detrital matter of this age, accumulated with very great rapidity, having a thickness at some points of more than fifteen hundred feet, and showing throughout evidence of the action of very strong currents,[1] for we everywhere have a more or less distinct cross-bedded structure. To suppose that the erosion of these materials occurred at the time of their deposition, or that they were deposited simultaneously throughout the area, seems to me quite unreasonable. The only way that I can solve the problem of its formation is by assuming that this mass of detritus originally occupied a coast-shelf. In the final elevations which converted a large part of this region into the land on which the coal forests grow, this mass of waste was torn up by the waves, and swept rapidly out to sea by tidal and other currents.

This hypothesis has the considerable advantage that it perfectly accounts for the rapid invasion of the waste into regions hitherto deep sea. The lifeless nature of the deposit would be a consequence of its relatively rapid movement, for it is a well-known fact that rapidly moving sands and gravels do not readily become occupied by marine life. The hypothesis of elevation accounts, moreover, for the great amount of cross-bedding shown in these rocks. None of these facts can be met by any other hypothesis that has been suggested.

It is readily seen that this method of interpreting the record which comes to us in our detrital formations, brings us in face of certain difficulties. Where we have a deposit laid down in the deep sea, we can safely assume that beds at corresponding heights above its base are synchronous, but in a deposit made in the fashion of our coast shelves, the succession of deposition is not the same. The part nearest the shore is deposited before the seaward part. The deposit is then essentially like a cross-bedded stratum on a large scale. Owing, however, to the great horizontal extent of the bed, it will not often be possible to prove the cross-bedding as we can when it is exhibited in a limited way. For instance, in the Kentucky district before described, the millstone grit has always been considered as of the same age in all parts of the area, but if I am correct, a long time must have elapsed after the deposit began in the eastern part of the strata, before the beds of the same stratum were laid down in the western part of the area, a time during which the land was lifted at least one thousand feet in altitude, and the coast-shelf pushed out over four hundred miles beyond its former position.

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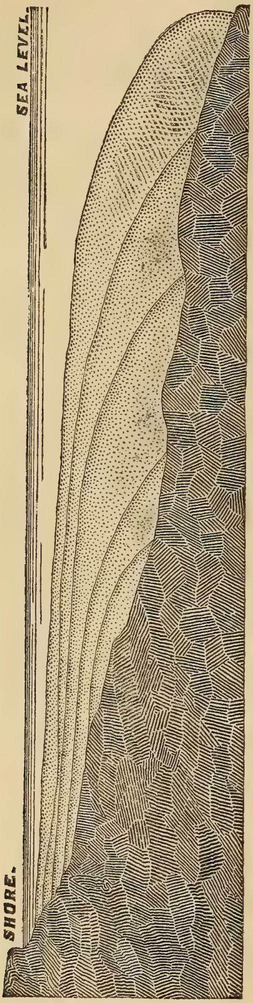
[1] The east and west sections, across this area of millstone grit, has a length of about four hundred miles, though erosion has divided it into several areas. The north and south extension is considerably greater.

It should be noticed, also, that a curious confusion may exist in these bedded deposits, a thickness of a few feet near the shore may represent hundreds of feet in deep water. This is best shown in the annexed diagram.



This doubt must always rest upon all coast-shelf deposits. When they are deposited rapidly, the difference in time taken in laying down of their shoreward and seaward borders may not be great; when they deposited slowly the difference may be great enough to lead to some confusion in the record.

It may also be noted, that on the seaward edge of such deposits the transition from a deep sea to shallow water species may be shown, while near the shore line there may be no such transition.

The conclusions suggested by this preliminary inquiry may be briefly summed up as follows, viz.: —

1st. The coast shelf is the place of storage of the coarser detrital matter worn from the land; it generally accumulates with great rapidity, principally through the carrying power of the tides.

2d. In case of subsidence, this shelf may be buried in the shape in which it is formed; in case of elevation it will be distributed on the deep sea deposits for a distance proportionate to the extent of the upheaval.

3d. Being essentially a cross-bedded deposit, though the false bedding is on too large a scale to be visible to the eye, the successions in time are not from below to above in the section, but from the shore line to the sea front.

Dr. Brewer showed a Sooty Tern, *Sterna fuliginosa* ♀, a tropical bird, shot on Lake Champlain, where the species seems to be growing abundant.

Mr. L. S. Burbank showed a fine specimen of glaciated granite, the gift of Mr. S. P. Litchfield, of Fitchburg, to whom the thanks of the Society were voted.

A vote of thanks was also passed to Mr. John A. Jeffries for a male specimen of *Passerculus princeps* Maynard.

General Meeting. May 21, 1879.

Vice-President Mr. S. H. Scudder in the chair. Twenty-eight persons present.

Dr. T. M. Brewer and Mr. Scudder read their papers presented by title at the last meeting — Additions to the List of New England Birds, and Palaeozoic Cockroaches.

Dr. Brewer showed a pair of humming birds, *Amazilla yucatensis* Gould, presented by Dr. J. C. Merrill, U. S. A., to whom the thanks of the Society were voted.

Section of Entomology. May 28, 1879.

Mr. George Dimmock in the chair. Nine persons present.

Dr. H. A. Hagen, in remarking on the small number of North American beetles whose early stages were known, said that Matthias Rupersberger had recently published a catalogue of the described European larvae, from which it appeared that of about 8,000 European beetles 1,255 have had their earlier stages described.

Mr. Dimmock reported the capture of the carpet beetle, *Anthrenus scrophulariœ*, on the blossoms of the June-berry, *Amelanchier canadensis*, and Dr. Hagen said specimens had been sent him that were feeding on hyacinths. To prevent the ravages done plum trees by *Phytoscopus clitellarius*, Dr. Hagen advised the use of printers' ink, applied as in the case of canker worms.

Mr. Henry Edwards spoke of variations observed in *Chrysophanus americanus*; some specimens have the spots suffused, forming a band, and in others all trace of spots are obliterated.

General Meeting. October 1, 1879.

The President, Mr. T. T. Bouvé, in the chair. Twenty-two persons present.

The following papers were read:

Danalite from the Iron Mine, Bartlett, New Hampshire.[1]

By M. E. Wadsworth, Ph.D.

Through the kindness of Mr. J. H. Huntington, of the New Hampshire Geological Survey, specimens of an unknown mineral from the Bartlett Iron Mine were placed in my hands for determination. From the following characteristics it is considered to be a variety of Danalite.

Crystalline form, isometric, in octahedrons which are frequently elongated in the direction of one of the rhombic axes. Angle $1 < 1$, 109° 30′, obtained by the application goniometer. The best measurements by the reflecting goniometer, gave the angle, 109 °40′, but the faces were so irregular that no accurate measurement could be made with this instrument. A thin section ground parallel to an octahedral face, and examined under the microscope, shows that the mineral is isometric, and contains minute fissures filled with a doubly refracting material. The mineral also occurs massive with implanted crystals.

Cleavage, none. Hardness, 5.5–6.

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[1] This paper was written in 1875, and the following one, on Picrolite, in the spring of 1876, and placed in the hands of Professor J. P. Cooke, Jr. Through inadvertence, they were neither published nor returned to the writer until the past summer. This explanation is due to myself, and as I have not been able to get at my specimens for over two years no re-examination has been made.

On account of the small amount of material at my disposal, none of the specific gravity determinations could be depended upon.

Lustre of the exterior of the crystals, vitreous; of the interior of the crystals and the massive parts, resinous, varying from feebly to strongly resinous.

Color: crystals, hyacinth red; the massive parts, and the interior of the crystals shading out to a very light brown.

Streak white to a light brown, resembling that of cassiterite and of some varieties of sphalerite. In a powder the color is a dirty white.

Translucent. Fracture, sub-conchoidal, uneven. Brittle.

In a closed tube, in a powder, it takes a darker color, and deposits a slight whitish sublimate.

Open tube, unchanged.

On charcoal fuses with intumescence to a black enamel after long heating, and becomes magnetic. Gives a coating of zincic oxide and plumbic oxide, the last but slightly; on addition of sodic carbonate the coatings become more marked, and if not too much soda is added it fuses to a feebly magnetic globule. If cyanide of potassium is added a coating (faint) of antimonious oxide is deposited, and the whole mass, after long heating, is absorbed by the coal.

It is slowly dissolved in borax, giving a faint reaction for manganese in the oxydizing flame. On adding potassic nitrate to the bead the amethystine tint of the manganese becomes strongly marked. In the reducing flame the bead becomes colorless or gives a faint iron reaction.

Slowly dissolves in salt of phosphorus, giving faint iron and manganese reactions in the oxydizing flame. The bead becomes cloudy in the reducing flame.

Dissolves in sodic carbonate with effervescence, and if potassic nitrate is added gives a strong manganese reaction.

Completely dissolves after some time in boiling concentrated hydrochloric acid, with evolution of hydrogen sulphide, and separation of gelatinous silica in flocks.

Dissolves in strong nitric acid after boiling some time, with separation of the silica, both in flocks and as a powder.

Fuses at 3.5 to 4 to a black enamel.

The mineral is associated with magnetite and quartz, together with galenite, pyrite, sphalerite, and pyroxene, or a mineral apparently isomorphous with pyroxene. The last four minerals occur only in small quantities. The massive parts of the mineral are mixed with and incrust the magnetite, while the octahedrons are crystallized in and impress the crystals of quartz, indicating their prior formation.

A very peculiar rock is found at the mine, of but limited extent however, composed of a triclinic feldspar and rhodonite, with a little galenite as accessory.

On account of the small quantity of the pure mineral at my disposal, some of the foregoing observations may prove erroneous.[1]

PICROLITE FROM A SERPENTINE QUARRY IN FLORIDA, MASS.

By M. E. WADSWORTH, Ph.D.

Through the courtesy of A. S. Wait, Esq., of Newport, N. H., a gentleman much interested in mineralogy, I received a specimen of a mineral labelled Asbestus, from Florida, Mass., but which I took from its general appearance to be picrosmine.

It gives the reaction for ammonia with turmeric paper, and in splinters blackens, burns white, becomes harder, and does not fuse except when the splinters are very fine. Chemical analysis shows it to be picrolite, and other specimens from the same locality which I have since received from Mr. Wait are evidently picrolite and chrysotile. The specific gravity (mean of three determinations), is 2.60.

The result of the analysis made by Mr. Melville caused me to partially examine the specimens labelled Picrosmine in the Harvard College Cabinet. The specimens are from the following localities:

(1) Firn in Windischmatrei.
(2) Kalserthal in Windischmatrei.
(3) Pfitsch.
(4) Pregratten.
(5) Pregratten.
(6) Locality unknown.
(7) Zöblitz, Saxony.

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[1] Since the above was written some analyses were made by Professor Cooke and Mr. Melville which showed that the mineral is a danalite, and, if I am not mistaken, that the zinc and manganese are in inverse proportions to those which they have in the Rockport danalite. A description of the occurrence of the Bartlett ron ore, written by Mr. Huntington in 1876, is given further on.

The first six specimens are from the Liebener collection, now belonging to the College cabinet, and were determined, I think, by Professor Adolf Kenngott, and the last specimen from Dr. Krantz, of Bonn.

All were found to be *fusible*, and all that were tried (some four or five) gave no reaction for ammonia.

The question might perhaps be fairly asked, if nearly all, if not all, of the so-called specimens of picrosmine are not varieties of serpentine, the optical properties of both being the same.

No analysis has been made since that of Magnus, while the localities have been multiplied. If Magnus rightly determined the pyrognostic characters, it seems from the foregoing that the localities have been, in some cases at least, erroneously multiplied. A similar examination of the specimens of asbestus made while cataloguing the College mineral cabinet showed that a large number of these belong to the fibrous varieties of serpentine. Should this call the attention of some chemical mineralogist to this field, which it would seem needs some investigation, the object of this little paper will be accomplished. Mr. Melville's analysis is appended.

ANALYSIS OF PICROLITE FROM FLORIDA, MASS. BY W. H. MELVILLE, A.M.[1]

The water was determined by ignition. The silica was separated by digesting the finely pulverized mineral in concentrated hydrochloric acid. In order to prove that the mineral was thus completely decomposed, the silica was weighed and then subjected to the solvent action of fine aqueous hydrofluoric acid. By fusion with sodic carbonate, the same percentage of silica was obtained. It may be well to state that the solution in hydrochloric acid does not gelatinize, but, after evaporation, deposits the silicic acid in the form of a powder. The sesquihydrate of iron was separated from that of aluminum by means of pure potassic hydrate, and aluminic hydrate subsequently precipitated from the filtrate by ammonia. Manganese was detected in the mineral, but in quantities too small to be appreciable. The magnesia was weighed as pyrophosphate.

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[1] It is but justice to Mr. Melville, who is now Assistant in Mineralogy in Harvard College, to state that this work was done while he was a post-graduate student, and that the object was simply to determine the mineral, not to make an elaborate analysis.

	1st Variety.	*2d Var.*	*At. Ratio.*
H_2O at 100° C.	.36	.36	
" above 100° C.	11.26	11.22	1.24
Si_2O	44.22	44.22	2.95
Fe_2O_3	6.61	7.91	.25
Al_2O_3	.53		.03
MgO	37.54	37.40	1.88
	100.52	100.11	

Bases	Silica	Water	$\overset{\prime\prime}{R}$	R
2.16	2.95	1.24	1.88	.28
2	3	1	6	1

From this ratio is derived the following formula:

$$4(\overset{\prime}{H}+\overset{\prime\prime}{R})3\overset{iv}{Si}, \text{ or } H_4, \overset{xii}{Mg}_4\overset{xii}{O}_{12}Si_3.$$

The calculated percentages corresponding to this formula are as follows:

$2H_2O$	9.57
$3Si_2O$	47.87
4MgO	42.56
	100.00

ON THE IRON ORE OF BARTLETT, N. H. BY J. H. HUNTINGTON, A.M.

The mode of occurrence of the iron ore of Bartlett is so unusual that a detailed description of the rocks in the vicinity seems to be necessary. Beginning in the west part of Jackson, and farther south in the east part of Bartlett, extending thence across and up the valley of the Saco, there is a large area where granitic rocks prevail. The north line of this granitic area extends south-westward from a point a few rods north of Jackson Falls across the line of Bartlett, then along the south slope of the summit of Iron mountain. After crossing Rocky Branch it turns somewhat northerly, and crosses the mountain range between Rocky Branch and Mount Washington river just north of Giant's Stairs. The southern boundary of this area is not so well marked, since in the vicinity of Mount Pequawket the granite is intimately associated with the porphyrite of that mountain. West and south of the Saco the granitic area extends far to the south-west, but the rocks we describe will be limited to the immediate valley of the Saco.

There are in this area three well-marked varieties of granite:

1. At Jackson Falls, and extending south to Mount Kiarsarge, which it seems to underlie, there is a variety of granite, which consists mainly of a feldspathic base, in which there are imbedded crystals of feldspar, generally orthoclase; these crystals rarely exceed a quarter of an inch in their longest diameter. Sometimes the rock contains a small quantity of quartz, and occasionally mica is discernible, when it very closely resembles the porphyritic granite of Von Cotta. This rock is largely developed in Albany, and in the Report of the Geological Survey of New Hampshire it is called Albany granite. In the area we are describing it is limited to the eastern part.

2. Another variety of granite, which is the aplite of the German lithologists,[1] outcrops on the west side of Ellis River, half a mile from Jackson village, at Humphrey's ledge, on the south-west side of the Saco, on the west side of Iron Mountain, and it extends from the lode down to Rocky Branch. It consists here chiefly of an aggregate of feldspar crystals, and the quartz does not form so large a proportion of the rock as elsewhere. When it is not affected by the weather the feldspar is always of a dark greenish color, and the crystals are usually about an eighth of an inch in their longest diameter. In most places, however, this rock consists of feldspar and quartz, but there are localities where the quartz is almost altogether wanting, and a little hornblende is sometimes sparingly disseminated through the mass; sometimes, though rarely, both quartz and hornblende are present. Microscopic sections of this rock from another locality show an aggregate of feldspar crystals which are largely infiltrated with quartz. At the mine we have also an aggregation of feldspar and rhodonite, an association that has never, to my knowledge, been found elsewhere. It was first noticed by Mr. M. E. Wadsworth.

3. The third variety is a typical granite, and consists of a light-colored feldspar, light gray quartz, and black mica. It forms a covering over the last, except in the valleys, and occupies the summits of all the higher ridges north of the Saco. It is called Conway granite in the first volume of the Geological Report of New Hampshire. At the mine a few blasts at the upper opening revealed the second variety, sometimes called Chocorua granite. A few rods west,

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[1] Naumann, Geognosie. I, 559. Zirkel, Petrographie, I, 495. Blum, Lithologie, oder Gesteinlehre, 136. Lasaulx, Petrographie, 332. Cotta, Lithology (Lawrence's translation), 333.

down the side of the mountain, this is the only rock. The Chocorua granite seems to have been a subsequent intrusion, since it forms *necks* that appear to have been protuded into the common, or Conway, granite without overflowing it. West of Rocky Branch, the only granite that outcrops, except on the point between it and the Saco, is the common variety — at least, until we get west of Bartlett.

It is possible that the last two may be contemporaneous, but they are so unlike in their physical characters, and the line between them where they come in contact is so sharply defined, that it makes it more than probable that they belong to different periods of intrusion. North of this granitic area in Bartlett, and westward, we have the coarse mica-schists and gneisses of the White Mountains. They form the summit of Iron Mountain, and here have a high, though variable, northerly dip.

In the granite, about ninety rods south of the line of the schist, we find the iron. The rock in the immediate vicinity of the iron is frequently discolored with manganese, and we have already noticed the fact that rhodonite and feldspar here forms a rock. This deposit of iron has been known for many years, and it was first noticed by Gen. Meserve, of Jackson, soon after the forests were destroyed by fire. It was visited by Dr. Chas. T. Jackson when he made the geological survey of the State, and it is thus described by him : " One of the veins at the upper opening measures thirty-seven feet in width in an east-and-west, and sixteen in a north-and-south, direction. The second opening, two hundred feet lower down the slope of the hill, exposes the ore, maintaining the same width. Three hundred feet lower down the vein is observed to narrow, and is but ten feet wide, and four hundred feet farther the width increases to fifty-five feet. Five hundred and forty-six feet lower still there is a small opening, or cave, twenty feet deep, where the ore narrows again. On searching to the westward of this great vein, at a distance, we soon discovered a new one, which appears to be of the largest dimensions. . . . Forty-nine feet farther westward the soil is full of angular fragments of the ore, indicating another vein. It is evident that this mountain is intersected by a great number of veins of excellent iron ore, and will furnish an inexhaustible supply. It is proper here to remark that it is composed chiefly of the peroxide of iron combined with a small proportion of the protoxide, and it contains a little manganese."

All the outcrops examined by Dr. Jackson were on the western slope of the mountain, towards Rocky Branch. When the locality was first visited by me there had been little change, except that most of the mountain was covered by a growth of trees. After visiting the outcrops mentioned by Dr. Jackson, I extended my search eastward, and found on the eastern slope of the ridge running towards Jackson several places where there were indications of iron, and at one point ore was found.

All the principal outcrops lie in a direct line running north-west and south-east, and the distance between the extreme outcrops is one hundred and seventy-five rods.

Since my visit in 1870 there has been considerable prospecting, with a view of developing the mine, and some four hundred tons of ore have been removed; how much of this is manganese remains to be determined. When only a few blasts had been made, a rock unlike that which appeared on the surface was uncovered, and is that we have described as aplite, or Chocorua granite. It is found immediately with or in close proximity to the iron. This rock here is chiefly feldspar of a greenish color, and is generally impregnated with galenite; and at the opening west of the main line of outcrops, instead of this we find sphalerite. Where this rock has been uncovered it is from four to six feet in width. In this we first found the mineral described above as danalite. It occurs more commonly, however, in the small, lenticular masses of quartz in the ore, but it is nowhere very abundant.

An analysis of the ore made for the survey of Dr. Jackson by Mr. Williams is as follows:

Peroxide of Iron	69.4
Quartz and Feldspar	25.2
Oxide of Manganese	2.7

Another specimen yielded

Peroxide and Protoxide of Iron	77.25
Quartz and Feldspar	21.40
Alumina	.15
Manganese	1.20

and it gave 5.3 per cent. of metallic iron.

The masses of this ore seem to be in vertical segregations, and some of these have been entirely removed by mining, though there are yet immense masses that are still exposed. In the Report of the

Geological Survey of New Hampshire for the year 1871 I made the following observation:

"As the ore here occurs in vertical segregations, there is more uncertainty as to its extending to a great depth than if the ore occurred in lodes in a stratified rock; but this uncertainty is in a measure counterbalanced by the large masses in which it occurs." The locality is easiest reached from Glen Station, on the Portland & Ogdensburg railroad.

NOTE ON THE STRUCTURE OF RHIZOPHYSA FILIFORMIS.

BY J. W. FEWKES. (With Plate 2.)

The interesting Siphonophore *Rhizophysa filiformis* was discovered and first described by Forskål. He gave it the name Physophora and does not seem to have separated it from Athorybia nor from that animal which is now known as *Physophora hydrostatica*. Many subsequent naturalists have confounded it with other genera, or considered it a mutilated stem of another physophorid whose swimming bells and covering scales had fallen off. Chamisso found a Rhizophysa in the northern Pacific, and Eysenhardt described it as a new species. In the classical work of Eschscholtz a third species is mentioned and referred to the genus Epibulia.

Brandt divides the genus into the two forms, Rhizophysa and Brachysoma, which differ only in the length of the body. As Gegenbaur rightly says, the latter genus may be simply a form of Rhizophysa with contracted stem.

Lesson, in his Acalèphes, gives a short description and drawing of Rhizophysa, between which in certain respects, as Huxley says, there is a lack of consistency. His so-called "paquets d'ovaries," which must be the reproductive organs described by Gegenbaur, as Huxley well comments, are described as "jaunês," and figured as bright pink. The imperfection of his knowledge of the genus, as we now understand it, is clearly brought out by the praise which he gives Delle Chiaje's description of another animal which was thought to be his own Rhizophysa.

Still another example of this animal was described by Huxley in his work on the Oceanic Hydrozoa.

Huxley evidently had the species of Rhizophysa called *R. Eysenhardtii* in the single specimen which he found in the Indian Ocean. The peculiar unbranched organs from the tentacles, the existence of the so-called sexual clusters at the base of the polypite, and the entire absence of any of the three kinds of tentacular knobs, seem to point this out very evidently. It rarely happens in Rhizophysa that the tentacular knobs are dropped by long confinement in a glass vessel, so that one could hardly believe the specimen which he had was mutilated. The thread-like character of the secondary appendage to the tentacle would seem to indicate the truth of the theory that they were only pedicles of secondary appendages whose sacculus had dropped off.

Huxley figures and describes the coeca-like appendages which are so well marked in the float of *R. filiformis*, and he declares himself unable to find the small rounded cells between the endoderm and the air sac. I was also unable to find these in my own specimens, a failure, I think, as such structures have been redescribed. Considering the problematic position of Velella and Porpita these bodies have more or less theoretical importance. If one should push the comparison of a Velella to a physophorid as far as Leuckart has in his schematic figure, one could better compare that dark mass which has been likened to a liver in the case of Velella with the finger-like, often bifurcated appendages of the float in Rhizophysa.

One of the best descriptions which we have of this animal is that by Gegenbaur. He observed it frequently in quiet weather in the neighborhood of Messina. I shall frequently have occasion to speak of his account.

Kölliker does not appear to have studied the form. No mention of it occurs in his work on the Siphonophorae of Messina. Leuckart and Vogt did not find Rhizophysa in the bays near Nice. The former of these authors declares in a note that the *Rhizophysa filiformis* of Risso is the same thing as the animal which he calls *Galeolaria filiformis*. Keferstein and Ehlers give a casual mention of it, supporting Sars's view in regard to the tentacular knobs. One of the last additions to our knowledge of the different Rhizophysidae, is a paper by Studer (Zeitschrift für wiss. Zöol., Bd. XXIV) on the Siphonophorae of the deep sea. I am inclined to question the validity of the new genus and species which he proposes. That these animals were brought up from the depths which he gives is also, as Mr. Agassiz shows, not conclusive. Among the few forms as yet described as belonging to the Siphonophorae from North American waters, no mention has been made of Rhizophysa. There is hardly a doubt that it will later be added to the number already known, especially when the waters of our southern bays have been more carefully studied.[1]

In the course of my work in Villefranche sur Mer, my fisherman brought me five or six specimens of *Rhizophysa filiformis.* I think the form is not common there, at least in the winter months. My specimens were taken in February and March. On account of its apparently mutilated condition, Rhisophysa is one of the most bizarre of the Siphonophores. This is mainly due to the fact that the bells, which fail among related forms in Physalia, are here completely wanting. They neither appear as swimming organs, covering scales, nor in the so-called sexual parts.

The float alone, that strangely modified structure which Metschnikoff has homologized to a bell, and whose form is so varied, is the only thing which we find in Rhizophysa representing a medusa bell.[2] Except the most limited movements of contracting the axis, the animal is wholly devoid of means of progression. The contrast between this and the rapid motion of a Galeolaria, darting through the water almost with the velocity of a Doliolum, is very great. The lower Siphonophorae, as Physalia, have some means, passive as they are, of progression, but Rhizophysa seems to stand alone among the Siphonophorae in its helplessness. The animal, however, has a certain prehensile power in its polyps not unknown among other Siphonophores. *Physophora hydrostatica*, which manifests phenomena of sensation more quickly than the other Siphonophores, will grasp a pencil in its so-called tasters, and cling to it with great tenacity.

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[1] Up to the present time, there have been described from New England waters only three forms of Siphonophorae. *Nanomia cara,* the only known Physophorid except Physalia, was studied by Mr. Agassiz. It was found by him at Newport and Nahant. In the summer of 1876, while at work in his laboratory at Newport, I found a second physophorous Acaleph, *Agalma elegans,* as yet neither described nor figured. Of Calycophoridae none have yet been found in New England waters by others. To this fauna I can add *Eudoxia Lessonii* and *Diplophysa inermis.* Velella is sometimes washed up on our coasts, and Physalia is by no means so rarely met with in Vineyard Sound as in Villafranca, Naples or Messina.

[2] The origin of the float has of late been studied in other Physophoridae by Haeckel, Kowalewsky and Metschnikoff. The opinion of the former that it is simply one end of the primitive cavity seems, after the investigations of the two last, to be erroneous, Metschnikoff and Kowalewsky both showing that it first appears as a simple bud, independent of the cavity itself. Kowalewsky believes that the float is first formed as an invagination. In Metschnikoff's figures of *Agalmopsis Sarsii* the float is represented as of ectoderm alone. Both ectoderm and entoderm enter into the formation of the bud, which is at first an invagination, as many of my own preparations show is the case in *Physophora hydrostatica.* The earliest stage of the young of Physophora is a true gastrula of the invaginate kind. The theory of the relation of the Siphonophorae to a budding Medusa and not to a free swimming hydroid was first suggested by McCrady. In late years it has been urged on embryological grounds by Metschnikoff and P. E. Müller. This theory is directly connected with the homology of the float. Homologically speaking there is very little difference between a free swimming hydroid and a medusa with attached and highly differentiated buds such as one finds them in the Siphonophorae. While Haeckel was the first to discover the resemblance of the larva of the Physophoridae to a young medusa and to homologize the provisional "deckstück' with the bell of a medusa, he looks upon the other later formed bracts as individuals after Leuckart's conception. It is a strange inconsistency.

That power is also, though in a less degree, possessed by the feeding polyps of Rhizophysa. The sensation however, in the whole body is very marked, as exhibited by the responsive contraction of the stem. When excited, the ability of the tentacles and their complicated tentacular knobs to grasp, is an additional element in the propulsive power of animals so helpless as Rhizophysa. Firmly seizing a floating weed, piece of wood, or even another living body (for I think at times even a large animal is fastened upon), it is thus moved from place to place by a foreign agent.[1] The Rhizophysa makes up in this way those means of progression of which it is destitute, but which even its own relations possess in such a highly developed form. The peculiar problematical organs, which since Leuckart's investigations have been commonly known as "tasters," are also wanting in Rhizophysa. Three or four of those feeding polyps nearest the float, bear a very great resemblance to these structures in other Siphonophores. They have the same simple tentacles, and mouthless stomachs, but are evidently only the undeveloped stages of true feeding polyps. Farther down on the stem we find them passing into tentacles with tentacular knobs, and true polyps with mouths.

The slender, needle-like shape of Rhizophysa, caused by its destitution of swimming bells, renders it a most inconspicuous object in the water. The long tentacles hang gracefully down far below the extremity of the animal, at times contracting at the very base of their polyps, and then leisurely dropping into their extended position with great facility. The highly contractile stem of the Rhizophysa shortens itself into a shapeless snarl, bringing with it feeding polyps and tentacles into a tightly coiled mass. In this condition, however, it remains but an instant, and the closely drawn spiral is gently uncoiled, and one after another of the tentacles gracefully extend to their normal condition. Gegenbaur gives the length of the stem of the animal as 1¼ ft.; certain individuals, however, reach much greater lengths, and some of the specimens I have studied measured three feet at least. The diameter varies in different positions along the axis. Directly under the float the stem is very small, and it increases gradually to the very distal extremity. For a Siphonophore of its size, the diameter directly under the float is very small as compared with other Physophoridae. A slight stem of the character found in Rhizophysa could not support swimming bells and covering scales so much developed as in Agalmatopsis or Halistemma.

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[1] I have never seen it grasp the sides of a glass dish in which it was confined, and pull its float under water as Huxley says. Still the anastomosing tentacular knobs have the power of firmly fastening themselves to a foreign object. These structures, however, it must be remembered, were not found in the species which Huxley had. Whenever I have found it attached, its whole body was coiled around the object very much in the manner in which it was found by Mr. Agassiz on the lines used by him in deep sea fishing.

The air-bladder or float of the Rhizophysa differs in one respect from that of any other Siphonophore. Enclosed in an enlargement of the stem, as that of the others, it has, from its under portion, branched and simple saccular appendages, which hang down from its lower surface. That into which they open is a very peculiar supplemental float, surrounding its lower hemisphere. As far as I am acquainted with the Physophoridae, these sacs are a peculiarity of Rhizophysa. Their function is unknown. They are wanting in certain Rhizophysidae described by Studer. The float has an opening into the surrounding medium, and the air can be expelled at the will of the animal. Gegenbaur saw the escape of air from the float when pressed, notwithstanding his previous declaration of its impossibility. This was first seen by Huxley. I have observed the float contracted, the air expelled in bubbles, the walls of the opening being at the same time protruded in a funnel-like structure. The opening is surrounded by dark crimson pigment spots, arranged with some regularity, and of polyhedral shape. I think they belong to the air-bladder, and are not on the external envelope. There is no opening from the float into the cavity of the stem. The float on the surface of the water always lies at right angles to the stem, as is shown in figure 2 of the plate. In this way the opening into the cavity does not lie at the apex of the animal, but at one end of the float. When we compare the float of Physalia with that of Rhizophysa, we find the opening in an homologous position at one end of the bladder-like float. It is therefore evident that the place of origin of the different parts along the under side of Physalia correspond more or less with the side of the float of Rhizophysa, and not with the point of attachment of the stem. We should expect the earliest developed oldest parts cf a Physalia to take an origin at a point or pole opposite the opening corresponding with the point of origin of the stem of a Rhizophysa. Such is the case with certain younger stages of Physalia which have been figured as new species.

The peculiar suspensoria which are so well marked in certain species of Agalmatopsis, are not present in Rhizophysa. The shape of the float itself is that of a prolate spheroid; the outline of the extremity of the stem which forms its envelope is pyriform. Both parts consist of two well defined layers. These layers fit closely together except on the lower hemisphere of the float, where they are separated to such an extent as to create a cavity into which the peculiar " coeca " like bodies open. This cavity, formed simply by a separation of the two component layers, can be voluntarily inflated in such a way as to be easily distinguished from the upper half.

In none of the Siphonophores have we a better opportunity to trace the development of the feeding polyps and tentacles than in Rhizophysa. Directly under the float the least developed polyps appear as simple buds from the stem, with no differentiation into stomach and tentacle. A more developed bud shows the origin of the tentacle as a supplementary extension of the wall of the polyp on its upper and basal surface. The secondary bud differs in no respect from the first, nor has it any differences from the polyp part itself. Indeed, both together form a bifid appendage whose component parts differ only in size. The subsequent growth has been very often described. It is nearly the same in Rhizophysa as in other Physophoridae. Only when we come to study the tentacular knobs and their development can we detect any marked variations from a common type of growth among the Siphonophores. For that reason these structures have always played a great part in the classification of the Siphonophore. We fail to find in Rhizophysa those characteristic pigment spots so well marked at the base of the feeding polyps of Agalmatopsis and Agalma. The polyps are of a uniform flesh color throughout, with little or no variations either at base or apex.

The tentacles do not differ from other tentacles as found among the Siphonophorae. They are composed of the same two layers, and arise from the base of the polyps. When the polyp is detached the tentacle never remains on the stem, but continues united to the base of the polyp.

The motion of the tentacles is for the most part a simple contraction and extension. The festoon-like position into which, according to Mr. Agassiz, the tentacles of Nanomia are thrown, is rarely seen in the tentacles of Rhizophysa. They hang listlessly down by the side of the stem, and, except when the animal is alarmed, are never moved. Their length, as compared with the distance between the polyps, is much greater than that represented by Gegenbaur.

The appendages to the tentacle are the most unusual structures in the organization of this curious Siphonophore. Nowhere do we find a similar complication of structure, nor so many different forms. Other Siphonophorae have as complicated types of tentacular knobs, but no adult more than one kind, nor do they serve for more than one purpose. Rhizophysa has three kinds of appendages attached to the tentacle, and I think these have three functions; each one of these parts passes through a distinct and more or less characteristic development.

Gegenbaur pointed out these three kinds of knobs, but did not trace the first to its adult condition. The figure which he gives corresponds with the undeveloped stage which I have figured in my plate. (Plate 2, fig. 5.) This form is immature, and passes into the more advanced condition, fig. 6.

Keferstein and Ehlers follow Sars in regarding the second kind of tentacular knob as developed from the first. That view is, I think, a wrong one, for the second kind of knob has a very different mode of development from the first, and has early formed structures which never appear in the former.

There seems little doubt that Gegenbaur was right in considering that there are three kinds of tentacular knobs, although he studied only the undeveloped form of the first.

The first and most numerous kind of tentacular knobs is found by hundreds along the tentacle, extending to its very extremity. As would be naturally expected, they are found in all stages of development, with the most distal the most complicated in structure. When fully grown, they are united to the tentacle by a secondary stem, which is highly contractile, and in structural character differs in no respect from the tentacle itself. They arise as simple buds from the tentacles, and in early conditions are sessile. It is only when more developed that the secondary stems are formed. In the first stages we have a club-like body, slightly constricted at its base and position of union with the tentacle. In this primitive knob there are many large lasso cells, always imbedded in the surface layer. These cells are described by Gegenbaur.

The first differentiation in the development, which up to this time presents no variation from that of other Siphonophores, is the aggregation of these cells at one pole, which is the distal extremity of the knob, and the formation of a finger-like extension, tipped by a cluster of smaller cells; this cluster of smaller cells is never lost, and forms one of the characteristics of the first kind of tentacular knobs. They may be seen in fig. 4, where the prolongation is greater than in subsequent stages.

From both sides of the under hemisphere of the knob a bud now forms, which is simply a proliferation of the walls of the appendage; fig. 5 gives an idea of the appearance of the knob at this stage. Lasso cells are scattered irregularly through these parts, which are smaller than the first formed, although larger than the cluster mentioned as existing at the apex. This is very near the stage which Gegenbaur regarded as the first form of tentacular knob; its development, however, is not yet finished.

The two side appendages lengthen, become more slender; the median portion becomes more spherical, and a well-defined neck forms at its base. The lasso cells, which were formerly irregularly scattered over the whole surface, aggregate into two clusters, one terminal and the other about midway down the arm. Various drawings were made of this stage, of which figs. 5, 6, 8 give a good idea. This is the most developed condition in which I have found the first kind of tentacular knob.

There is a remote resemblance between this knob and that of the genus Agalma. The envelope so well known in this genus is, however, wanting. It would be very hard, in the present stage of our knowledge, to carry out such an homology, which may be only superficial, but it would be a convenient way to designate this kind of an appendage, from others yet to be mentioned, if it were known as the Agalma-like knob.

Very different in the method of development from that of those already mentioned is the history of the second kind of tentacular knobs of Rhizophysa. Like the former structures they also arise as simple buds, but their subsequent growth is very different. Their developed form is characteristic of the genus under consideration, and does not bear even a superficial resemblance to the tentacular knobs of other Siphonophorae. They are larger and less numerous than the former. The adult form is well described by Gegenbaur, to whose account I refer the reader. He does not mention the power of progression which one of these has when separated from its stem, nor the grasping power possessed by the different branches. Both of these characteristics I have often watched under a glass of low power.

The first stage of this tentacular knob is also a simple bud, but of very different natures are the subsequent forms of the two. Fig. 9 represents the simple spatulate outline in the youngest stage; it is devoid of lasso cells, and larger than the younger stages of the other. In the former case one of the earliest differentiations was the formation of a median or apical cluster of smaller cells; here, however, we find an apical depression, as shown in fig. 10. Scattered lasso cells have appeared, but in a different position from what we found them in the former case. Fig. 11 gives us a view where the depression has grown still deeper.

A new and secondary division now appears, so that, as in fig. 12, we have the knob divided into four parts; one large and two smaller depressions forming four bifurcations. The lasso cells have clustered upon these projections as represented in the figures. The tentacular knob now differs little from the completely developed, and subsequent growth is simply a bifurcation and prolongation of these four parts into branches, at the extremity of which is always a black spot, as represented in fig. 12.

There is in this stage a peculiar cell, larger than the rest, which I have sometimes thought was an opening, and connected with higher organs of excretion or sensation; this peculiar structure appears in the angle of the larger branches at the point (A). In the adult it is a cluster of pigmentary bodies of dark yellow color, surrounded by a wall, or enclosed very much as an otolith. Gegenbaur mentions it in his text, but does not figure it. In no fully grown Rhizophysa is this structure absent, and in the youngest stages it can be seen as a simple, prominent cell.

I have nothing of importance to add to Gegenbaur's description of the third kind of tentacular knob, except that it does not follow the type of development of either of the two mentioned above. It seems to resemble more the tentacular knob of a Calycophore, as a Galeolaria or Diphyes, than the same structure in the Physophore.

Between the polyps are curious organs of botryoidal appearance, which are commonly called the sexual organs. They have never been found with any structure which can be likened to a germinative dot or vesicle, nor have the male been distinguished from the female elements; indeed, they differ so greatly from sexual parts as generally met with among Siphonophorae, that one is almost in doubt whether they are really parts of this system or not. The interior has a ciliated surface, as Huxley pointed out. Situated on the stem between every pair of polyps, except those in close proximity to the float, we find from one to five of these clusters, wholly isolated from the remaining parts of the animal. Like the other organs of the body, these parts develop also as simple buds, of two layers, in the form of a small bladder, smooth in outline and destitute of lasso cells.

The first change in the growth is the formation of irregularities on the whole surface, as shown in fig. 14. These irregularities originate in wart-like projections on the surface, and present an appearance whose outline is given in fig. 15.

The structure resembles, as Gegenbaur says, a "Morgenstern", one of those mediaeval weapons in use before the introduction of fire-arms. The whole organ, in its histological structure, is composed of two layers: an outer layer, composed of transparent fibres with an intermixture of lasso cells; and an inner, sharply defined from the former, and clearer, destitute of cells, and apparently lined with cilia. I do not know certainly whether cilia exist, although both Huxley and Gegenbaur declare that the innermost surface, or the wall of the cavity, is ciliated. The different prominences of the botryoidal structure become more irregular in outline; the single elevations, instead of being spherical, take the irregular triangular form shown in fig. 17. That condition is followed by a specialization of growth at one angle, as shown in fig. 19. When the growth has proceeded still more, as in fig. 20, we notice near the apex of the prolonged portion a singularly large lasso cell, which remains constant in the more developed forms. Other adjoining cells of like nature make their appearance later, as seen in figs. 21, 22; the whole cluster is united, as seen in fig. 16. It sways to and fro independently, and can be contracted or expanded, as is the case with similar organs among other Siphonophores.

The peculiar cells which I have mentioned are not germinative vesicles as their number and variations plainly indicate, but more especially as seen in the absence of the germinal dot. I am inclined to think these so-called sexual organs are unisexual, and that we have in these animals a case unlike Gegenbaur's *R. Eysenhardtii*.

Mr. Alex. Agassiz mentions and figures in his account of Nanomia a most wonderful and unique form of development of the young Nanomia from a bud, as well as from the egg; he considers an egg development also to be present, but apparently did not find the very early stage of the egg.[1] Such a method of development by a bud has only been observed in this single case, and by him alone. Rhizophysa may have a similar form of development in these botryoidal structures. Certainly there is very little resemblance between the oldest observed stage, which I have figured, and the egg or male organ as found among the Siphonophorae.

Note. The following is not a complete list of the literature of the Siphonophorae but of works mentioned in this paper.

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North American Acalephae. 1865.
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Claus. Neue Beobachtungen, etc. Zeitschr. f. wiss. Zool., Bd. XII. 1863.
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Delle Chiaje. Descriz. et notom. degli anim. invert. della Sicilia. Tom. V.
Eschscholtz. System der Acalephen.
Eysenhardt. Nov. act. Leop. Carol. Tom. X. 1821.
Forskal. Descript. animal. etc., quae in itinere orient. collegit. Harniae, 1775.
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Haeckel. Zur Entwickelungsgeschichte der Siphonophoren. Utrecht, 1869.
Huxley. Oceanic Hydrozoa. Ray Soc., 1859.
Keferstein und Ehlers. Zoologische Beiträge. Leipzig, 1861.
Kölliker. Die Schwimmpolypen oder Siphonophoren von Messina. Leipzig, 1853.
Kowalewsky. Göttinger Nachrichten. 1868.
Lesson. Acalèphes.

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[1] According to Metschnikoff, *Nanomia cara* is simply a member of the old genus Stephanomia. He does not seem to give importance enough to this peculiar budding development. Its existence in one and not in the other, would be sufficient cause for a generic difference, yet it remains to be seen whether such a method of reproduction does occur in Stephanomia; further study of the history of the young of Nanomia is also needed

LEUCKART. Zur näheren Kenntniss der Siphonophoren von Nizza. Berlin, 1854.
Zoologische Untersuchungen. Giessen, 1853.
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MCCRADY. Gymnopthalmata of Charleston Harbor. 1857.
METSCHNIKOFF. Studien über die Entwickelung der Medusen und Siphonophoren. Zeitschr. f. wiss. Zool. Bd. XXIV.
MUELLER, P. E. Iagttagelser over nogle Siphonophorer. Kopenhagen. 1871.
SARS. Middel havets Littoral-Fauna. 1857.
VOGT. Rech. sur les Anim. infer. de la Mediterranée. Premiére Mém. sur les Siphonophores de la Mer de Nice.

EXPLANATION OF PLATE 2.

1. Rhizophysa filiformis. *a.* Float. *b.* Stem. *c.* Feeding polyps. *d.* Tentacle. *e.* Grape-like clusters.

2. Customary position of the float on surface of water.

3–8. Tentacular knobs of the first kind.

9–13. Tentacular knobs of the second kind.

14–22. Botryoidal clusters found between the polyps, and known as sexual organs.

23-29. Early stages of development of the first kind of tentacular knob. View from the side.

All the figures are optical sections except fig. 1.

In response to a request from the chair, Dr. M. E. Wadsworth gave a brief sketch of some results of his studies in the Lake Superior region during the past summer, of which he proposed to give a fuller account in a paper to be read before the Society at a future meeting.

Mr. L. S. Burbank, Prof. W. H. Niles, the President, and others, remarked on some of the points referred to by Dr. Wadsworth.

Dr. Thos. M. Brewer announced the gift of a specimen of the Shearwater, *Rhyncops nigra*, taken at Wood's Holl, by Mr. J. F. Carleton, to whom the thanks of the Society were voted.

A vote of thanks was also passed to Mrs. S. B. Cragin for gifts to the Museum.

General Meeting. October 15, 1879.

The President, Mr. T. T. Bouvé, in the chair. Eighty-two persons present.

Prof. Edward S. Morse communicated some observations he had made on the antiquities of Japan.

The shell heaps he had explored in various parts of the empire, extending from the west coast of Yeso to Higo were described. Among many interesting features of these heaps, the remarkable changes undergone by the species of Arca found in them — important from an evolutionary point of view — were especially noted. A description of typical dolmens near Osaka was also given. Prof. Morse finally gave an account of his explorations of a large number of caves of supposed Corean origin, and of the pottery he had found in them.

Mr. H. W. Haynes spoke of the importance of Prof. Morse's communication on the dolmens in Japan, and sketched briefly their distribution in Asia, North Africa and Europe.

Mr. F. W. Putnam remarked on the character of the shell-heaps of the Atlantic and Pacific coasts of North America, comparing them with Japan, and alluded to the importance of a comparative study of the shell-heaps in various parts of the world. He then stated that it would be of interest to the members, in connection with the discovery of dolmens in Japan, as described by Prof. Morse, to know that within twenty-four hours there had been received at the Peabody Museum a small collection of articles taken from rude dolmens (or chambered barrows as they would be called in England), recently opened by Mr. E. Curtiss, who is now engaged, under his direction, in exploration for the Peabody Museum.

These chambered mounds are situated in the eastern part of Clay Co., Missouri, and form a large group on both sides of the Missouri River. The chambers are, in the three opened by Mr. Curtiss, about eight feet square, and from four and a half to five feet high, each chamber having a passage-way several feet in length and two in width, leading from the southern side, and opening on the edge of the mound formed by covering the chamber and passage-way with earth. The walls of the chambered passages were about two feet thick, vertical, and well made of stones which were evenly laid without clay or mortar of any kind. The top of one of the chambers had a covering of large flat rocks, but the others seem to have been closed over with wood. The chambers were filled with clay which had been burnt, and appeared as if it had fallen in from above. The inside walls of the chambers also showed signs of fire. Under the burnt clay, in each chamber, were found the remains of several human skeletons, all of which had been burnt to such an extent as to leave but small fragments of the bones, which were mixed with the ashes and charcoal. Mr. Curtiss thought that in one chamber he found the remains of five skeletons and in another thirteen. With these skeletons there were a few flint implements and minute fragments of vessels of clay.

A large mound near the chambered mounds was also opened, but in this no chambers were found. Neither had the bodies been burnt. This mound proved remarkably rich in large flint implements and also contained well made pottery and a peculiar "gorget" of red stone. The connection of the people who placed the ashes of their dead in the stone chambers with those who buried their dead in the earth mounds is of course yet to be determined.

A letter from Dr. Harrison Allen, of Philadelphia, Pa., acknowledging his election as Corresponding Member was read.

Section of Entomology. October 22, 1879.

Mr. S. H. Scudder in the chair. Eight persons present.

The following paper was read:

A NEW SPECIES OF SIMULIUM WITH A REMARKABLE NYMPHA CASE. BY H. A. HAGEN.

The species belonging to the dipterous genus Simulium are famous for their injurious habits. Some of them, the fly from Columbatz and the African tsetse, have been well known long ago as terrible cattle pests. The fauna of the United States contains a small number of species, some of them as noxious as those above named. The well-known "black-fly," the most dreaded pest to visitors of mountain regions, is still known only by the manuscript name *S. molestum.* Perhaps we may very soon have a scientific description of this species, as, contrary to its previous custom, it has been during the last spring not uncommon at Jamaica Plain, in the neighborhood of Boston.

I am able to make a remarkable addition to the genus and to our fauna by the discovery of a new species, *Simulium pictipes* Hag., by Dr. R. P. Edes and Prof. H. P. Bowditch, in the Adirondack Mountains, N. Y. In the rapids of the Ausable River, a little less than two thousand feet high, the pupal pouches were found fastened on rocks in clusters. A number of these, together with some larvae and a few just hatched imagos, preserved in carbolic acid, were given me for scientific investigation. As this species is much larger than any known American species of Simulium, and the pupal pouch is of a peculiar construction, I believe I am justified in giving a description of this new addition to our fauna.

Simulium pictipes sp. n.

Head velvety black; eyes brown; antennae black, the two basal joints in the female rufous, in the male nearly as dark as the other joints; palpi grayish, the basal joint black; thorax black, almost shining, on each side in front with a quadrangular ashy white spot; halteres opaque, white; abdomen black above, pale grayish beneath and on the sides; trochanters black; coxae brownish; femora white, black at base and tip; tibiae white (two-thirds), tip and extreme base black; a black external line connecting tip and base; tarsi of front legs black; of the other legs, the first joint white, black on tip (one-fourth) with an inferior black line; following joints black, the base of the second white; wings sub-hyaline, veins fuliginous, costa darker.

Length of female, 6 mm., of male 5.25 mm.; wings, nearly 5 mm. Habitat, Ausable River, Adirondack, N. Y., in August. I have seen four females and one male; the opaque, dull colored wings seem to indicate that the specimens were newly hatched.

The nearest related species known is *S. piscicidium* Riley (Amer. Entom., II, 367). This species is much smaller, measuring 0.14–0.17 while *S. pictipes* measures 0.22–0.24 inch. After giving due allowance to the fact that the specimens were just transformed, and perhaps the body and wings not yet duly hardened, and that they were preserved in carbolic acid, still the difference in size is far too great to assume that the specimens could, by duly hardening, be reduced to half of the size.

The differences between *S. pictipes* and *S. piscicidium* are the lack in the former of any fulvous pubescence of the thorax, the presence of ashy white spots in front of the thorax, the black trochanters of the front legs, the color of the femur, the black band of the tibia, and of the first joint of the middle and hind legs, and the white base of the second joint.

Among the unnamed species in the collection of the Museum of Comparative Zoology is one from Illinois of nearly the same size, but otherwise different. All other described North American species are much smaller.

Nothing is known about the habits of *S. pictipes*; probably it is not as obnoxious in the mountains as its relation, the black-fly, otherwise it would have long ago drawn the attention of travellers by bites in proportion to its size much larger than those of the black-fly.

The larvae, partly full grown, are 12 mm. in length, and do not differ from those described, as far as I am able to judge by the descriptions. The pupa is 6 mm. in length, and has on each side eight filaments, arising from a common root, just as the figures in Verdat, repeated in Osten-Sacken's paper in Amer. Ent., II, 229. The only species represented in the biological collection of the Museum, *S. ornatum* from Europe, has only four filaments on each side, just as figured and reported by Fries, and therefore do not favor Osten-Sacken's opinion that Verdat's species is identical with *S. ornatum.*

The pouch or case in which the pupa lives is 7–8 mm. long, and differs remarkably from all the described species. It forms a tube 2 mm. wide at top, smaller at the base, of a very irregular and coarse network; sometimes a thread is coiled around the tube in an irregular manner. I can nowhere find mention of any network or threads making the pouch of one of the other described species. The network is similar to that of some Tenthredinidae. A cluster of such pouches is fastened one near the other with the base on rocks, and imitates somewhat a small wasps' nest. It is rather remarkable that young and mature larvae, pupae and imagos were found together at the same time on the same spot.

General Meeting. November 5, 1879.

Mr. F. W. Putnam in the chair. Twenty-nine persons present.

The following papers were read:

ON THE EVIDENCE OF COMPRESSION IN THE ROCKS OF THE BOSTON BASIN. BY W. O. CROSBY.

So long as the distortion of pebbles of hard materials — such as quartzite, granite, etc. — in conglomerate rocks continues to be called in question by able geologists, the description of what seem to be clear examples of this species of lithological metamorphism will be timely and important.

Before setting forth the new evidence which has recently come under my notice, I will call attention to some general facts tending to prove, or proving, the former existence of an efficient compressing force in the rocks in this vicinity.

That the Primordial rocks in the Boston basin — the puddingstone and slate — have been powerfully compressed by a force acting in a definite direction is proved not only by the folded state of the strata (the dips across almost the entire basin being steep and frequently alternating), but also by a well-marked cleavage, developed in many portions of the slate, and by fractured and flattened or distorted pebbles in the conglomerate.

The plicating force, in this region, appears to have operated with nearly equal intensity from the south-south-east and north-north-west directions, producing flexures which are approximately parallel with the axis of the basin; although showing a tendency at most points to conform in direction with the adjacent crystalline border. The cleavage of the slate, though nowhere remarkably perfect, is very noticeable at many points. Hewitt's Cove in Hingham, Mill Cove in Weymouth, Slate Island, Rainsford Island, and the north shore of Squantum are good localities for observing this structure. The strike and dip of the cleavage planes are very constant, the former agreeing very closely with the average strike of the bedding, while the dip is almost invariably to the north at a high angle, 70°–80°.

Although among the pebbles of the puddingstone hard materials — quartz, quartzite, granite, petrosilex, etc. — largely predominate, yet comparatively soft pebbles are not at all uncommon. These are frequently argillaceous; but a large proportion, however, consist of a greenish and somewhat unctuous substance which many observers have mistaken for serpentine, but which is easily proved to be aluminous and not magnesian, being some form of the protean mineral pinite — a hydrous alkaline silicate of aluminum.

As a general rule, the pebbles composed of these relatively soft and, as it were, permanently plastic materials have suffered an extraordinary amount of deformation, appearing usually as thin lenticular plates, or as contorted layers enveloping harder pebbles. At several points the pudding stone is almost entirely composed of this class of pebbles; and these, being flattened in parallel planes, give rise to an imperfect cleavage, which agrees exactly in dip and strike with the cleavage in the slate. In such cases the cleavage exists not only in the rock as a whole, but in the individual pebbles as well. The best exposure of pinite conglomerate showing well-marked cleavage is on Central Avenue in Milton, about one-fourth of a mile south of the Neponset River.

Turning now to the question of the distortion of the harder pebbles in the puddingstone, I hope to show that, although, as we should naturally expect, the evidence is very much less abundant than in the case of the relatively soft pebbles, it is, perhaps, scarcely less conclusive. That compressing forces of considerable magnitude and efficiency have operated in all parts of the conglomerate is evidenced by the phenomenon observable in scores of localities of hard pebbles which, not receiving equal support at all points from surrounding pebbles, have been fractured transversely. Many pebbles show only one fracture, while others are divided by several parallel clefts; and as a rule the fragments have experienced slight but unequal movements in the direction of fracture.

Prof. W. H. Niles has called attention[1] to the facts (1) that, in certain parts of the puddingstone at least, the fractures, which may be considered equatorial with reference to the pebbles, are mainly at right angles to the strike of the beds, or in the probable direction of the compressing force; (2) that in the polar direction there is often a manifest tendency to the extension of the materials of the rock, the fragments of the fractured pebbles being drawn asunder, and the cement separating from the ends or poles of the pebbles; (3) that the cavities thus produced between the linear elements of the pebbles and at their poles have often become repositories of segregated minerals, chiefly crystalline quartz; (4) that some of the pebbles in the conglomerate at Chestnut Hill Reservoir seem to have been *compressed, or flattened without fracture, i.e.*, to have been truly plastic.

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[1] Proc. Bost. Soc. Nat. Hist., xv, 1.

I have not seen the flattened pebbles to which Prof. Niles refers, but the pebbles which I have observed at another point in the same belt of conglomerate, and to which I wish to call the attention of the Society, have outlines that, as it seems to me, can be satisfactorily explained only on the supposition that the material has been slightly plastic. The precise locality of these pebbles is the ledge of pudding stone on the north side of North Beacon Street, a few rods west of Everett Street, in the Brighton district of Boston. The pudding stone, at this point, is inclined to the north at an angle of about thirty degrees; and the exposure is very satisfactory, having an area nearly one hundred feet square, and presenting on the north a straight, smooth slope of rock parallel with the bedding. The conglomerate includes many limited layers of slate and sandstone. These are most numerous toward the north, and the ledge is terminated in that direction by a bed of sandstone several feet thick. The slaty layers are mostly quite small,— a few inches to several feet in diameter,— and often present the general aspect of pebbles, though they are probably mainly due to irregular sedimentation. They all show a well-marked cleavage in planes parallel with the bedding.

The pebbles of the conglomerate, which, with rare exceptions, are well rounded, are of all sizes up to a foot or more in diameter; the average diameter, however, not exceeding two or three inches. They are principally composed of a very firm, whitish, fine-grained quartzite, several varieties of petrosilex, and granite. The quartzite pebbles predominate, and it is in this class chiefly that the outlines appear to be distorted. The distortion of the pebbles is most noticeable in those portions of the conglomerate where they are most thickly placed, and I have failed to detect any deformation where the pebbles appeared to be entirely isolated in the paste; actual contact of pebble with pebble seeming to be essential to the distortion, though I am possibly in error here.

The general outlines of the pebbles are rarely extensively altered; *i.e.*, as a rule there is no sensible flattening of the pebble as a whole, but we find instead indentations and local flattenings. The indentations are usually quite shallow, and, since the quartzite is a rock little affected by weathering, they are most favorably exposed on the weathered surfaces of the conglomerate. I have satisfied myself, however, that they really exist on all sides of the pebbles, the action of the weather being simply to remove the cement and expose the true forms of the pebbles. The conglomerate is so firm that a pebble dislodged by the hammer usually carries with it enough of the cement, or adjacent pebbles, to obscure all but the deepest impressions.

These indentations or dimples present some very curious features. In the quartzite pebbles especially, the surfaces which have yielded are remarkably smooth, smoother than an ordinary weathered surface, — smoother even than a glaciated surface; in fact the compression appears to have compacted and polished the material, the pebbles being case-hardened as it were, at the points where the pressure was applied.

A large majority of the impressions are very long in proportion to their breadth; appearing as shallow grooves on the surfaces of the pebbles, and reminding me of finger-marks on a ball of putty. I consider this elongation of the indented surfaces as their most puzzling characteristic, and no entirely satisfactory explanation has yet occurred to my mind. It seems necessary to suppose that the pebbles have slipped over each other in the rock. The longest grooves are more than three inches long, and at least four times longer than broad. They sometimes extend on the surfaces of the pebbles through an arc of nearly ninety degrees; and occasionally the same groove is continuous across two or three small pebbles. The elongated impressions appear to pass gradually into those of more normal form; and must, I think, be explained in the same way.

Where two impressions lie near together on the same pebble, the tendency to squeeze up the material between them to an acute angle is sometimes very evident. Although occurring on all sides of the pebbles as they lie in the rock, the indentations are found principally on the two opposite sides which coincide with the bedding; the line connecting the indented surfaces of a pebble usually passing through its centre and in a direction perpendicular to the strata. This constancy of position is especially characteristic of the elongated impressions, the great majority of these being found on the upper northern aspect of the pebbles; and their direction is equally constant, being almost invariably east-west, or parallel with the strike of the conglomerate. There are places on the ledge where thirty or more of the grooved pebbles may be counted in a square yard, the broad, shallow grooves nearly all lying in the plane of the bedding and trending east-west.

So far as the impressed pebbles are concerned, the evidence is plain that the compressing force has acted mainly in a direction normal to the surface of the beds; and this is precisely the direction required by the cleavage of the slaty layers.

Fractured pebbles are numerous in some parts of the ledge, and as a rule the fragments have been drawn asunder one to five mm. by a stretching or squeezing-out force ; while among both the fractured and unfractured pebbles there are abundant examples where the paste has separated from the ends or poles of the pebbles in obedience to the same tendency. The fractures and cavities are frequently transverse to the strike of the rock, though sometimes coinciding with it; but they all agree in being at right angles to the bedding of the conglomerate. In other words, the fractures, cavities and indentations of the pebbles, and the cleavage of the slaty layers, in this ledge, all require compression in a direction perpendicular to the stratification; and this, I think, goes far to prove that the peculiar concave surfaces, or indentations, of the pebbles, are really the effect of pressure, and indicate that the now rigid quartzite has been formerly somewhat plastic.

I have already stated that the elongation of many of the indented surfaces of the pebbles seems, if we accept the theory of their former plasticity, to require us to suppose that the pebbles have slipped over each other in the rock. But when we consider the fracturing of the pebbles, and the cavities formed at their ends and between their linear elements or fragments, it is impossible to deny that the rock has suffered an appreciable extension in the plane of the bedding; and therefore the relative movement or slipping of the pebbles in a definite direction must be accepted as an established fact.

The elongated impressions can not be ascribed to glacial action, either before or after the deposition of the pebbles, on account of the variety of positions in which they are found and their nearly constant east-west trend. And if it were possible to conceive of any mode of attrition by which these forms could be developed, such an hypothesis would be equally negatived by the uniform direction of the grooves. That these indentations have been produced since the pebbles reached their present positions in the rock is unquestionable; and they must be the result either of pressure or of fracture. If we regard them as simply conchoidal fractures, we shall still find it impossible to connect them with either the jointing of the rock or the transverse fissures of the individual pebbles. It is, of course, possible to break these materials conchoidally; but the smoothness and uniform direction of the concave surfaces, and the fact that they are not limited to the present surface of the conglomerate, appear to me insuperable objections to the fracture theory. I accept the compression theory, not as entirely satisfactory, but as beset with fewer difficulties than any other. The numerous fractured pebbles show that the degree of plasticity has not been great; and in some cases the distortion of the pebbles is clearly the combined result of fracture and plasticity. Some plasticity is certainly required in those cases, of which I have observed several in this ledge, where a fracture producing a fissure one-eighth or even one-fourth of an inch wide on one side of a pebble terminates before reaching the other side. There are many points in the Boston basin where the hard, fine, quartzite pebbles constitute the main part of the conglomerate; but I have never observed the curiously indented pebbles outside of the ledge in Brighton here described, although since these were first discovered I have searched for similar phenomena in scores of ledges in various parts of the basin.

Dr. M. E. Wadsworth, in criticism of the views held in the preceding paper, said:

The question presented to us this evening by Mr. Crosby, has been one of much interest to this Society and to American geologists. The subject was first brought before the Society on the evening of January 4, 1860, by Edward Hitchcock, Jr., at which time he claimed that the pebbles in the conglomerates at Newport, R. I. and at East Wallingford and Fairfax, Vt., had been distorted and elongated while in a plastic state after deposition. This view was opposed by Dr. Chas. T. Jackson, who contended that similar forms could be seen any day on our beaches. (Proc. Bost. Soc. Nat. Hist., VII, 209.) In October Professor Edward Hitchcock brought the subject again before the Society (Proc. VII, 353), and was opposed by Dr. Jackson. Prior to this at the Newport meeting (August, 1860. Proc. A. A. A. S. XIV, 112), of the American Association for the Advancement of Science, Prof. Charles H. Hitchcock read a paper on the "Geology of the Island of Aquidneck," in which he held that the Newport conglomerate had been in a plastic or semi-plastic state since its consolidation, and that the contorton and elongation of the pebbles took place then.

Professor Edward Hitchcock in 1861, in an elaborate paper (Amer. Journ. Sci. (2) XXXI, 372), gave numerous examples that he regarded as proving his views, which were the same as those given above. In the same journal (p. 440), Professor W. B. Rogers opposed the views advanced by Professor Hitchcock in his communication (before mentioned) to the Boston Society. This paper of Professor Rogers was given before this Society on the 17th of November, 1860.

Professor Hitchcock's views upon this subject were more fully presented in his Report on the Geology of Vermont (I, 28–45). The subject was again brought forward by his son, Professor C. H. Hitchcock, in his Reports on the Geology of Maine (I, 177, II, 244, 324), new localities given and similar views advanced. In 1867, at the Burlington meeting of the Am. Assoc. Adv. Sci. (XVI, 124), this latter gentleman also called the attention of that Society to the subject.

At the Buffalo meeting of the same Society, 1866 (XV, 83), Mr. B. S. Lyman, prior to this, had opposed the views of Professor C. H. Hitchcock regarding the Newport conglomerate.

Professor George L. Vose read a paper, January 3d, 1868, "On the Distortion of Pebbles in Conglomerates," etc., which was published in the Memoirs of this Society (I, 482–487). The locality especially described was the one at Rangely Lake in Maine. He objected to the idea that the pebbles had ever been plastic, but considered that the indentation, bending, elongation, and even a change into a "homogeneous crystalline mass resembling syenite," had been produced by pressure simply.

At the Salem Meeting of the Am. Assoc. Adv. Sci., 1869, (XVIII, 199–205), Mr. Wm. P. Blake called attention to some conglomerates and slates in Arizona and California, in which he thought similar contortions and elongations had taken place, and regarded mechanical force alone as the agent.

We again revert to this Society when at the meeting of May 19th, 1875, Professor Wm. B. Rogers brought up the old question of the Newport conglomerate, and opposed the view that the pebbles had ever been elongated by pressure, but that these forms were natural shapes produced by beach action. (Proc. Bost. Nat. Hist., Soc., XVIII, 97–101). In the same volume, (p. 224–225), can also be found some remarks upon the conglomerate of Harvard, Mass., by Mr. L. S. Burbank, in which he claimed some very remarkable contortions and elongations of pebbles were to be seen. The subject was also earlier discussed by Professors Niles and Shaler and Dr. Jackson. (Proc. Bost. Soc. Nat. Hist. xv, 1–3).

The attention of American geologists was first called (so far as I am aware) to this subject by Professor Edward Hitchcock in 1859, in a paper presented to the American Association at the Springfield Meeting (Proc., XIII, 355), entitled, "On the Conglomerate near Newport, R. I., with elongated Pebbles and transverse Joints." This paper was not published. My experience with this subject has been limited, but such as it is, it would lead to the conclusion that many of the cases relied upon to prove the indentation, flattening, and bending of pebbles after their deposition have been misinterpreted. It was my fortune in the summer of 1874 to accompany the Assistant Geologist of the New Hampshire Survey for some weeks in the survey of that state. This gentleman, from his association with Professor Charles H. Hitchcock, was an enthusiastic believer in the plasticity and distortion of conglomerate pebbles, and pointed out numerous examples of their supposed occurrence. Not one of these examples seemed to me to sustain either the premise or conclusion, the form being such as can be seen any day on the beach where pebbles of like lithological character occur. In the summer of 1877 the locality pointed out by Professor Vose was visited, but nothing was found to sustain the arguments or conclusions of his paper. Since that time microscopic sections of the slates and so-called conglomerates mentioned by Mr. Wm P. Blake as sustaining his conclusions have been examined by me. These are from the Sierra Nevada, and are designated in his paper as "gravestone slates." To the eye the so-called "conglomerate made up of flattened pebbles," appears to be composed of a detrital mud holding fragments of argillite. Microscopic examination shows that the rock is composed for the most part of diabase detritus. The crystals of augite remain very perfect in most cases, and no mark of distortion by pressure was seen anywhere. The evidence is very strong that this was deposited as a mud flow. While in general the longer axis of the fragments and crystals is parallel with the lines of flow, many examples of crystals and fragments arranged at all angles were seen. As far as can be told by a microscopic examination of Mr. Crosby's "pinite schist," it is the same as, or similar to, the Californian rock spoken of above. From the specimen exhibited I hardly think any *mineralogist* would call the fragments serpentine, neither is it evident that any

On page 315, fourth line from bottom, for microscopic read macroscopic.

chemical analysis is able to prove that a mineral aggregate is a simple mineral (pinite).

Forms that are more curved and irregular, elongated and distorted, than any that I have seen in the conglomerates, have been picked up by me on the sea beach and preserved for inspection at the Museum of Comparative Zoology. That these forms are products of fracturing and wearing is shown by the absence of any signs of twisting of the laminae and by the stratification (in the stratified specimens) being continuous at both ends and worn across in the centre. The lamination and stratification do not correspond with the contours of the pebbles. Attention is called to this, lest it should be claimed that the specimens had been bent in some conglomerate, which had since been broken up and its debris deposited on the shore. If one listens to the grinding and rubbing, when even a moderate swell strikes against the shingle he will wonder not at the amount of wear the pebbles show, but at the smallness of it, compared with that which one might expect. This is probably owing to the buoyant and cushioning effect of the water. The wear is, however, sufficient to give numerous singular forms which are directly proportional in number to the average force of the waves beating upon the shingle in question : rare in sheltered spots, quite common in exposed ones.

The pebbles from the conglomerate that Mr. Crosby has brought before us to-night were found on an elevation which was evidently of similar form during the glacial epoch. As this formed the crest and side of a little, exposed ridge, it was very powerfully abraded. The pebbles being of quartzite (indurated sandstone) have been less affected by weathering than most of the pebbles of a different nature, and therefore retain much of the original glacial gouging, tearing and polish nearly intact. As the matrix is less resistant than the pebbles, the latter, besides having their tops planed off, were generally more or less rounded on their sides. This rounding naturally took place where the matrix was most continuous and abundant, *i.e.*, parallel to the bedding planes. Where the surfaces have been exposed to weathering since, the matrix has decomposed, setting free the coarse quartz sand, of which it is largely made up. Certain of the markings upon the pebbles that have been ascribed to indentation have probably been produced by the churning of this sand by the rain against their sides, and by the wear of the sand carried in the little streams produced by the rain. The matrix is so closely adherent to the sides of the pebbles, that oftentimes the pebble will be broken before the matrix can be removed. The pebbles of course break with a conchoidal fracture, and must have done so under the pressure of the glacier. This fracture will account for the peculiar form of the upper surface of many of these pebbles. I believe that glaciation and the action of water and sand since, have caused the markings that Mr. Crosby claims to have been formed by the pressure of one pebble into another when plastic, and by the slipping of one over the other.

As far as I have been able to ascertain by examining the locality carefully several times, it is true that while these forms can be seen by the thousands on the glaciated surface, not one can be found in the interior of the conglomerate nor where the surface was removed some years ago by quarrying. While Mr. Crosby contends that very many of the forms were made by the sliding of one pebble over another, I can hardly imagine that so much sliding could have taken place at the present surface and no where else in the conglomerate. While the bedding is uniform and inclined to the surface, the flattened planes of the pebbles are generally parallel to this surface throughout its contours, and the rounded edges conform in like manner to it, never extending below the matrix. These forms are found on solitary pebbles, in the coarse sandstone at this locality, on the glaciated surface where we have not the slightest reason to suppose any pebbles have existed to indent them. The flattening (so called) has taken place on the upper surface while the lower side of the pebble retains its normal form. Many of these pebbles are fissured and the fissures filled with crystalized quartz. This fissuring it is claimed took place at the time of the flattening and indentation of the pebbles, but I find that the supposed indentation has gone into the fissures, removed the quartz and polished their walls at the upper part. Some of the polished forms that are exhibited to-night are in such angular and irregular shapes that it seems impossible that they could have been made by the pressure of one pebble into another. As these pebbles are composed of little sand grains they are conglomerates on a small scale, and doubtless have been compressed as any fragmental rock is liable to be. The indentations supposed by me to have been produced by pressure at this locality are little rounded depressions entirely unlike the forms shown here. If the pebble had been plastic and squeezed, as it is claimed, the grains of sand, being thus plastic, would have been flattened and drawn out. Signs of the pressure would be readily discernable in the structure of the pebbles, but I can find nothing of the kind. The sand grains are as round as those upon the sea shore.

THE TUBES IN THE LARGER NECTOCALYX OF ABYLA PENTAGONA. BY J. WALTER FEWKES.

The course of the chymiferous tubes in the larger swimming bell of *Abyla pentagona* has never been satisfactorily described. Leuckart gives the best description of the very peculiar form of these tubes in the smaller bell, but simply says of them in the larger that "he could with certainty follow them to the circular vessel."[1] In the drawing of this nectocalyx, which he gives in his Zoologische Untersuchungen, Taf. III, fig. 1, he represents four of these vessels as passing directly from a common origin to the circular tube just as is the case in a simple hydroid Medusa.

Neither figures nor descriptions by other writers give a correct idea of the course of these tubes. In most cases, as in the figures of Abyla in the Oceanic Hydrozoa of Huxley,[2] they are wholly omitted both in the upper and lower nectocalyces. In one figure Kölliker[3] gives a correct idea of their origin, but the drawing was only made to illustrate the structure of the smaller bell, so that the peculiar modifications in the course of these tubes in the lower part of the larger bell were not given. Of Vogt's[4] description, Leuckart[5] says, "Die Gefässe der hintern Schwimmglocke, die von Herrn Vogt nicht erwähnt werden, könnte ich u. s. w."

Gegenbaur gives a good description of the branched vessel which I have lettered e^1 and c^1.

As is well known the under side of the lower nectocalyx of Abyla, as it naturally floats in the water, forms a groove protected on either side by a ridge. From the side of the smaller of these ridges is formed a plate under which the stem of the Abyla is withdrawn. Kölliker[6] gives a schematic drawing of the relation of this plate to the side of the bell. The existence of this plate causes certain deviations in the normal course of the chymiferous tubes in the bell. Although their course is not so abnormal as that of the tubes in the smaller bell, it is still quite curious. Four chymiferous tubes arise from the single central tube which communicates with the stem cavity of the animal. Of these, three pass directly to the circular tube which they join, forming at the point of junction an enlargement. One of these continues along on the under side of the bell, following almost exactly the ridge, which forms, by being continued, the most prominent circumvelar projection of the bell. From its junction with the circular vessel, where a conspicuous enlargement is formed, a secondary tube arises which extends along the bell almost parallel with the normal tubes, and when under the junction of the protecting plate and ridge of the bell enlarges and sends out three short digitate branches. I do not know what the homology of this secondary tube is. At times it arises not from the enlargement but from the vessel itself. The fourth of the four chymferous tubes, which arises from the common junction, passes a short distance down along the bell, and then divides, one part extending at right angles across the bell for about a quarter of the distance around the nectocalyx, and then turning again at right angles goes on parallel to its former course to join the circular tube. An indistinct drawing of a part of this tube can be seen in one of Kölliker's plates, but is not mentioned in the text. The former of the two branches into which the tube is divided extends directly on to the vicinity of the digitate-like structure already mentioned, but is then not probably joined to it. Gegenbaur leaves nothing new to be said of this abnormal vessel.

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[1] Zur nähern Kenntniss der Siphonophoren von Nizza, p. 14, 1854.

[2] Oceanic Hydrozoa, pl. II, fig. 1, 1^a, 2, 2^a,

[3] Schwimmpolypen oder Siphonophoren von Messina, Tab. X, fig. 2.

[4] Sur les Siphonophores de la Mer de Nice.

[5] Siphonophoren von Nizza, p. 14.

[6] Neue Beiträge zur näheren Kenntniss der Siphonophoren, p. 355.

Such is the course of the tubes, not in a single specimen alone, but in hundreds of Abylae, as studied when alive or when acted upon by reagents. The tendency of the chymiferous tubes of the Acalephae to vary in their course is well known. The constancy of form in this case seems to indicate that it is an anatomical peculiarity of the bell. The plate which covers the stem when it is drawn to the side of the bell, into the longitudinal canal, is not a "deckstück" nor homologous to these structures. The existence, however, of this plate or so-called canal, is no doubt the cause of the peculiar variation of the tubes from the usual arrangement.

If we look for the homological solution of this plate we may conclude that it is the recurved extended edges of the ridge rising on the side of the groove, which shelters the contracted stem. Similar ridges, less developed to be sure, are found in all the Diphyidae. Perhaps no where is this development carried so far as in the two irregularly circular lappets under the opening of the bell in Epibulia (Galeolaria), which structures play such an important part in directing the animal as it darts back and forth through the water.

The two-paged paper of McDonald[1] on the nervous system in Diphyes, Leuckart in his "Bericht," rightly criticizes as follows: "Was McDonald bei Diphyes als Nerven-system beschreibt, reducirt sich auf die an die Schwimmglocken tretenden und darauf sich vertheilenden Gefässe." He does not add upon what ground he bases such a conclusion. In Abyla the resemblance of these so-called tubes to a nervous system is great, but we know so little of their nature, and indeed of their course, even in the distal swimming bell of such a common Calycophore as *Diphyes Sieboldii*, that at present any generalization is premature. It seems to me that these structures are homologous to the chymiferous tubes on account of their position, and origin. I cannot understand, however, how what McDonald gives "affords presumptive evidence of the existence of a similar system in other forms of Oceanic Hydrozoa," as the title to his paper reads. In Physophora, Halistemma, Agalma and Stephanomia (Fårskalia), we know that similarly placed structures in the nectocalyces are chymiferous vessels similar to those found in the hydroid Medusa. In Epibulia (Galeolaria), the Calycophore where these structures in the distal nectocalyx have often been described[2] and figured, they are without doubt true tubes as in the Physophoridae already mentioned. Such facts render it probable that these are also chymiferous tubes in Abyla.

Leuckart says,[3] "Die Firste, die den Längskanal bildet, ist ohne gefäss." The "längskanal," if I am not wrong, is the same as the cavity or canal on the under side of the larger nectocalyx, as it generally swims, one side of which is formed by what I have called a plate. Into this cavity the stem can be drawn. My specimens, which are from the Mediterranean, show the rudimentary tube, which I figure.

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[1] Ann. and Mag. Nat. Hist., 114-116.

[2] Gegenbaur. Beiträge zur näheren Kenntniss der Schwimmpolypen, 1854, p. 35, Taf. XVI, fig. 8. Leuckart. Siphonophoren von Nizza, p. 33-34, Tab. XI, fig. 14. See also Zool. Untersuch. Vogt, Sur les Siphonophores de la Mer de Nice. Delle Chiaje. Descriz., etc., V, p. 135.

[3] Zoologische Untersuchungen, p. 57.

This rudimentary tube runs directly under the ridge which seems to me the same as that which has the letter (c) in Leuckart's figure, Pl. III, fig. 6, Zool. Untersuch. The secondary tube, which originates from an enlargement where the right hand tube, looking at the lower surface of the bell as it swims in the water, joins the circular vessel, and which ends in the digitate portion described, may also be related to this rudimentary tube.

As the nectocalyces of all Physophoridae, exclusive of course of Athorybia, Physalia and Rhizophysa, where they do not exist, have bilateral symmetry as referred to a plane, passing through ventral and dorsal line as defined by Claus and Haeckel,[1] and as the same occurs also in Gleba (Hippopodius), and the second nectocalyx of Epibulia (Galeolaria), we have an anterior and posterior or superior and inferior spheromere as well as a right and left. These spheromeres resemble each other, and in most Siphonophores have the chymiferous tubes passing directly to the circular vessel, while the lateral spheromeres have tubes which do not pass so directly, but make a curious turn. *Abyla pentagona* does not present in its larger nectocalyx a bilateral symmetry of this kind in its chymiferous tubes. One side of the larger bell, however, is different from the other, in that it has the longitudinal canal (Längskanal), covered by a plate into which the stem is withdrawn on one side which is wanting on the other. I propose to call that the inferior side of the large nectocalyx. If the float is made out to indicate the anterior end of a Siphonophore in the Physophoridae, as to my knowledge it never has been, and if (as I believe), Leuckart[2] is right in considering that the somatocyst ("Saftbehälter," "Athemhöhle,") of a Calycophore is homologus to one of those little blind tubes (" Mantelgefäss,") on the median tube of the nectocalyx of an Agalma, these two sides of the larger nectocalyx of Abyla may be called anterior and posterior. Whether we use the terms anterior or superior all depends upon whether the float indicates the anterior extremity of the stem from which it buds or the superior end of the same, together with a true homology of the regions of the nectocalyx of a Calycophore. The inferior side of the second swimming bell can be distinguished in *Diphyes Sieboldii* where two bounding ridges are continued on into two projections. The section thus marked out is not a spheromere, for it has no tube in it. It is easily to be recognized in Epibulia (Galeolaria), where it has homologous circular plates which can almost close over the entrance to the bell. In the two larger nectocalyces of Praya the difference lies rather in the enlargement of the superior spheromere than in any ridges with similar appendages. In the larger nectocalyx of Abyla I think there is nothing to represent the pair of appendages to the medial canal (Mantelgefässe) which one finds in *Agalma Sarsii*, and one of which is represented by the gastric cavity in the upper, smaller bell. In *Praya diphyes*,[1] both of the large bells have these appendages present; in *Praya maxima*, however, it is only in the smaller nectocalyx that this Mantelgefäss exists; a condition, as far as this is concerned, not unlike that in Abyla. Among Physophoridae the difference between superior and inferior spheromeres even in Apolemia is very slight. In Agalma, Agalmopsis (Stephanomia) Halistemma, Stephanomia (Förskalia), and Physophora it is very small. I would limit this inferior side of the bell in the genus Abyla by the tubes which pass to the circular tube. The smaller ridge which lies midway between the two larger, under which the tubes have such a modification, would then lie medially in this side. About a plane passing through this line, or indeed any longitudinal line in the larger swimming bell of Abyla, no bilateral symmetry can be said to exist as is the case in the tubes of the nectocalyx of many other Siphonophores.

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[1] Leuckart led the way to the institution of the term ventral line when he showed that the appendages all arise from one side of or in a direct line on the stem. Leuckart. Zool. Untersuch, p. 14. Archiv für Naturg., 1854.—Claus., Zeitschr. für wiss. Zool. XII, 7, 27.—Haeckel. Zur Entwick. der Siphon., p. 12.—Claus, Halistemma tegestinum, p. 5.

[2] Leuckart. Zoologische Untersuchungen, p. 10.

I do not know what to consider the homology of this secondary tube in Abyla. It does not seem to be homologous to a side branch of a radial tube as in Willia, or if it is, that does not explain the other secondary branch already described, as also its existence in only one segment. A fifth chymiferous tube is a thing unknown in the nectocalyces of Siphonophorae. The secondary tube has some likeness to that connecting branch marked with a little star in Leuckart's figure, passing over the superior part of the anterior bell of Epibulia (Galeolaria).

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[1] In my studies at Villa Franca I took *P. maxima*, *P. diphyes*, and a third species which I do not know. I have followed Gegenbaur in his distinction between these two species. Gegenbaur. Beiträge zur näheren Kenntniss der Schwimmpolypen. p. 19.—Leuckart, Zur nähern Kenntniss der Siphonophoren von Nizza. p. 40. For synonomy see Keferstein und Ehlers. Zoologische Beiträge pp. 20–26.

I give a figure of an Epibulia in my collection which illustrates this point. An objection to a comparison of this kind would be that we have in one a superior part of the first nectocalyx, and in the other, the inferior of the second. The two nectocalyces of Diphyes, Abyla, Epibulia and Praya, are probably homologous. The smaller, or anterior as they swim, may be called the superior, and the larger the inferior nectocalyx. It seems to me that the terms superior and inferior as applied to the nectocalyces and to the sides of the same would be preferable to proximal and distal, for then, since we have a right and left side to the bell, there would be more uniformity in the names of different sections. A somatocyst is, with one exception, confined to the superior bell. It is, however, almost impossible to homologize the different spheromeres of the inferior nectocalyx of Abyla, Diphyes and Epibula. Along the medial line of the inferior side of Epibula passes a chymiferous tube. Where is this tube in Abyla and Diphyes? I have found nothing in either of these genera to represent a tube along the medial line, and lying in a plane, in reference to which such a bilateral symmetry exists as we find in Epibulia.

Closely connected with the discussion of the homology of the chymiferous vessels in Abyla, the importance of which in an appreciation of bilateral symmetry among Siphonophores cannot be overlooked, comes the question of the relationship of certain appendages to the lateral tubes in Apolemia. These vessels I have figured and lettered *j* in figs. 2 and 5. Leuckart (Zeitsch. wiss. Zool., p. 10), finds in them the representatives of the Mantelgefässe of Agalma, Praya, and Gleba. He says: "Bei Apolemia werden diese Kanäle (Mantelgefässe) von mehreren kurzen fast zottenförmigen Gefässausstülpungen vertreten, die unter rechten Winkel aus dem obern Bogen der Seitengefässe hervorkommen und in die Substanz der Schwimmglocken hineinragen."

I figure, I think for the first time, a single such vessel, fig. 6 *j*, appended to the lateral tubes of Epibulia.

In my figure of the nectocalyx of the Apolemia I have represented in addition to these structures a true Mantelgefäss not unlike the same structure in Gleba. It seems to me more natural to compare the tubular appendages in figs. 2, 5 and 6 with the connecting branch *k* fig. 5, than with the so-called mantle vessel which is the same thing as the somatocyst. I have not found a like comparison made by others.

Explanation of Plate 3.

Fig. 1. *Abyla pentagona.*

Fig. 2. Nectocalyx of *Apolemia uvaria.*

Fig. 3. Superior nectocalyx of *Epibulia aurantiaca.*
This drawing represents the course of the tubes in the superior side.

Fig. 4. Superior nectocalyx of *Epibulia aurantiaca.*
This figure is a view from the right side.

Fig. 5. Inferior nectocalyx of *Epibulia aurantiaca.*
A representation from the left side.

Fig. 6. Inferior nectocalyx of *Epibulia aurantiaca.*
Seen from the inferior side.

Figs. 3, 5, 6, in order to avoid a complicated figure, show only the tubes on the side towards the observer.

For the same purpose also the tract, polyp, tentacle, etc., are not shown on the stem of Abyla near where it leaves the longitudinal canal.

Fig. 2 is double the natural size of the specimen drawn.

Figs. 1, 3, 4, 5, 6, are four times the natural size.

a. Lateral chymiferous tubes.
b. Superior tubes.
c. Lateral chymiferous vessel.
c′. Branched tube peculiar to Abyla.
d. Origin of the same.
e. Inferior tubes.
e′. Secondary portion after division.
f. Connection of radial vessels with stem cavity.
g. Enlargement at junction of radial and circular tubes.
g′. Secondary vessel from the enlargement *g*.
h. Somatocyst.
i. Circular vessel.
j. Appendages to the lateral tubes which are in
k. Connecting branches.
l. Protecting plate.
m. Circular lappets, used to direct the animal in swimming.

General Meeting. November 19, 1879.

Vice-President Mr. S. H. Scudder, in the chair. Forty-six persons present.

The following candidates were elected to Associate Membership: Messrs. Walter P. Manton, E. Bentley Young and Prof. John M. Ordway of Boston; Mr. Quincy E. Dickerman of Somerville; Prof. C. H. Fernald, Orono, Me.; Prof. Geo. H. Stone, Kent's Hill, Me.; and Mr. Warren Upham, of Nashua, N. H.

Mr. Ernest Ingersoll gave a sketch of the present and past distribution of the Oyster in the Gulf of Maine and adjacent coasts.

Prof. A. Hyatt read a paper by Mr. A. P. Whitfield on some remarkable changes undergone by *Lymnaea megasoma* in confinement.

The following paper was presented by title:

THE DEVELOPMENT OF THE DIGESTIVE TRACT IN MOLLUSCS. By W. K. BROOKS, PH.D., ASSOCIATE IN BIOLOGY, JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD.

As long as the homology of the germ-layers and of the structures derived from them in the subordinate groups of Metazoa remains in uncertainty, any general hypothesis as to their homology throughout the entire group of Metazoa is clearly premature; and I do not think that any one who is acquainted with the recent literature on the development of Mollusca will dispute the statement that our knowledge of the mode of origin of the endoderm, the digestive cavity, the mouth and the anus in the various groups of the Molluscs is at present too fragmentary and inconsistent to admit of any general comparisons.

While certain observers state that there is a real invaginate gastrula stage of development, others deny that there is any thing of the kind in the embryology of any mollusc; and of those who describe a more or less modified gastrula stage some state that the blastopore becomes the mouth, some that it becomes the anus, some that it becomes neither, and some that it becomes both. In the present state of our knowledge it is impossible to say how far this lack of agreement is due to an actual difference in the history of the digestive tract in different molluscs, and how far to imperfect or erroneous observations. That it is in part the result of error is shown by the fact that the account of the various observers who have studied the development of the same mollusc, are often as contradictory and irreconcilable as the papers on different classes or orders.

I have been engaged lately in studying the embryology of a number of molluscs belonging to different classes and orders, and in a few of them I have traced all the stages in the formation of the digestive tract, and have obtained results which seem to me to be perfectly satisfactory and conclusive as far as these forms are concerned. An illustrated paper which is now in print, upon the development of the Oyster, and another which is also in press, on the development of the fresh-water Pulmonates, will give a detailed account of my observations upon the history of the digestive tract in these forms, and the present paper contains only an outline statement of the points in regard to which I feel certain.

A comparison of the papers upon the development of the Pulmonata which have been published within the last few years by Ray Lankester, Rabl, Fol, Ganin and von Ihering, will furnish an ample reason for the revision of the embryology of this group, for there is hardly a point in the early history upon which these observers agree.

The following is a list of those leading points in the development of Pulmonates of which I feel confident:

1. The polar globules make their appearance at the formative pole of the egg, and mark the plane of first cleavage, and the principal axis of the egg.

2. After the egg has divided into four equal spherules, the protoplasm of each spherule undergoes a process of segregation; that which occupies the formative end, and which is destined to give rise to the ectoderm, becoming quite transparent, while that which occupies the nutritive pole is opaque and granular.

3. The formative ends of the four primary spherules separate as four micromeres, while their nutritive ends become converted into four much larger, opaque macromeres.

4. By the division of the micromeres and by the separation of others from the formative ends of the macromeres a layer of cells, the

ectoderm, is formed and entirely covers the four macromeres except at a point, the blastopore, which is at the nutritive pole of the egg, and directly opposite the polar globules.

5. The four macromeres now become fused together, forming an oval granular mass of protoplasm, part of which separates in such a way as to form a layer of cells, the endoderm, arranged around a primitive digestive cavity, which opens externally at the nutritive pole of the egg, through the blastopore.

6. The remainder of the granular mass divides up into a number of large cells which are situated in the body-cavity between the ectoderm and endoderm.

7. These large cells are not to be regarded as a food yolk, for they grow with the growth of the embryo, instead of decreasing in size, and they soon become united to the surface of the digestive tract by a layer of mesoderm.

8. The neck which unites the digestive tract to the blastopore now lengthens, its cavity becomes obliterated, and the ectoderm cells about its outer end become converted into the shell area, upon which the circular symmetrical embryonic shell soon makes its appearance.

9. The mouth originates as an independent invagination of the ectoderm, which makes its appearance on the ventral surface of the body, about 90° from the blastopore, but which is soon pushed, by the growth of the foot, to a point almost directly opposite the primitive opening.

10. It pushes in towards the digestive tract but does not unite with it until after the blastopore has closed and become covered by the shell.

11. The stomach cavity appears to be the same as the primitive digestive cavity.

12. After the "rectal plug" has been formed by the lengthening and closure of the "invagination neck," its outer end moves from its primitive position in the centre of the shell area to a point on the ventral surface between the foot and the shell. Here it unites with the ectoderm to form the definitive anus, and an axial cavity which now makes its appearance converts the rectal plug into the intestine.

13. The structure and history of the shell area and velum are substantially as they have been described by Ray Lankester, and I have nothing to add to his account of the later stages.

14. During segmentation the alternation of periods of segmenting activity with periods of rest is very conspicuous.

In many particulars the history of the digestive tract of the oyster is quite different from its history in the Pulmonates, although there are also many points of resemblance.

The following are the leading points which have been made out in the oyster :

1. Segmentation takes place in substantially the manner described in various Lamellibranchs by Lovén, Rabl, and more minutely by Flemming, and there seems to be ample evidence to establish this as the normal form of segmentation in the whole class. It is peculiar in this, that although the egg is very small and contains very little deuteroplasm, the greater part of the yolk has the morphological without the physiological characteristics of a food yolk. Segmentation is restricted to the formative pole, and gives rise to a layer of cells which spreads down around the single larger spherule at the formative pole; this represents the food yolk, so far as its relation to the process of segmentation goes, although it contains a single nucleus, and no more food material than is contained by the segmenting portion oi the egg. A comparison of Flemming's figures of the process of segmentation in the very small egg of Anodonta, with the figures which Brobetsky gives of the same stages in certain prosobranchiate Gasteropods whose eggs contain a large and functional food yolk will show this similarity.

2. After the segmentation of the formative pole has given rise to a layer of cells which nearly covers up the single large spherule at the nutritive pole the latter begins to divide, and the egg at the same time becomes flattened, and finally saucer-shaped, with the concave surface formed by a layer of cells which have been produced by the division of the single macromere.

3. The edges of the saucer-shaped embryo approach each other, thus converting it into a gastrula, with a primitive digestive cavity and an external opening or blastopore.

4. The edges of this opening continue to approach and finally meet and unite, thus surrounding the endoderm on all sides by a layer of ectoderm, and leaving its central cavity without an opening.

5. After the lips of the blastopore have met and united to close the opening, its position is indicated for a short time by a groove on the outer surface of the body. The two valves of the shell make their appearance, entirely separate from each other, at the lateral edges of this groove, which thus becomes the shell area.

6. The mouth is formed as an invagination of the ectoderm, directly opposite the region where the blastopore was situated at an earlier stage.

7. The anus makes its appearance soon after, close to the mouth, and therefore nearly opposite the position of the blastopore. The intestine appears to be formed by an outgrowth from the digestive tract.

The pulmonate and the lamellibranch are thus seen to resemble each other in having the blastopore converted into the shell area, and the mouth formed nearly opposite by an invagination of the ectoderm.

In both groups the anus is distinct from the blastopore, and is formed after the obliteration of the latter and the formation of the mouth, but the invagination neck of the pulmonate migrates from its primitive position to the new anus, and becomes converted into the intestine, while the intestine of the oyster appears to have no relation whatever with the invagination neck.

The critical discussion of these facts and the comparison of them with other published observations will be undertaken in another place after the figures of the various stages have been published.

Mr. S. H. Scudder offered a few suggestions concerning the probable age of Haulover Beach at the head of Nantucket Harbor.

The conformation of the northeastern part of Nantucket is very peculiar, the easterly extension of the harbor being separated from the ocean by only a narrow strip of land on the north, and by a still narrower one on the east. So low and so narrow is this strip next the upper extremity of the harbor, that by digging a short and shallow trench through the sand dunes, the fishermen have constructed a very easy " haulover " for their boats. The question of opening this narrow neck of land to the free passage of the sea has been mooted by officers of the U. S. Coast Survey ; this, they say, is both perfectly feasible, and could be done at a comparatively small expense. It is believed that by means of tidal currents which would naturally flow through such an opening, the channels in the present difficult approaches to Nantucket Harbor would be deepened and broadened. Whether this result would follow and the Haulover beach remain permanently open would depend in large measure upon whether this neck of land is as old as the rest of the island or a more recent production of tidal currents. If the passage has ever been open and afterwards closed by the action of the sea, the same process would probably follow with an artificial breach, or at least the cutting could be kept open only at a great and constant expense.

The beach between the sea and the harbor at this point is nowhere more than two or three metres above high water, and to all appearance is wholly composed of dune sands. There are, however, some important indications that it is as old as the island itself. With slight differences, consisting mainly of the greater or less amount of clay commingled with the gravel, the structure of the eastern bluff of Nantucket is essentially the same from Siasconset on the south to Haulover Beach on the north. It is interrupted once at Sachacha Pond, where the sea occasionally sweeps across into the lake, but there are broken patches of the old bluff still remaining, and no one could believe that the material underlying the low beach at Sachacha was not so old as that underlying the bluffs near at hand. The bluff to the north of Haulover beach, although at its southern end formed only of blown sand, is further on identical in structure with that to the south of the beach; so also is that which skirts the head of the harbor on the northern side, where it is full of boulders of considerable size, showing that the whole Coskata district to the north was formerly part and parcel of the original island.

In this case, one point of connection of the two now separated bluffs must have been at Haulover beach. Although, without further testimony, it appears the more probable, it does not follow, that the present beach is a remnant of the old; since the beach may have been entirely destroyed, and then, by the changed action of the sea, induced by some altered relations of currents, been reconstructed. There is, however, one feature in the beach itself which seems to preclude the latter supposition; for, near its northern limit, but still far from the gravelly cliffs beyond, may be seen a single small thin patch of stratified clays underlain by layers of compacted ferruginous gravels, such as could not have been formed upon a beach at or above tide water, and essentially resembling similar patches in the bluff further southward. The patch is doubtless the last remnant of the cliff formerly existing here, but which has been torn down by the sea upon one side and the harbor upon the other. The Haulover beach is therefore but a repetition upon a larger scale of the Sachacha beach to the south.

General Meeting. December 3, 1879.

The President, Mr. T. T. Bouvé, in the chair. Twenty-six persons present.

Mr. J. W. Fewkes showed portions of an Indian skeleton recently exhumed in Newton, on the banks of the Charles River. With the skeleton was found a box-turtle shell, evidently buried with it. Various circumstances indicated a considerable antiquity.

Mr. F. W. Putnam said that the bones shown by Mr. Fewkes were very interesting.

He gave several measurements of the skull and long bones, which had just been taken by Mr. Lucien Carr, assistant curator of the Peabody Museum of Ethnology. The skull was very long and narrow, and from its slight structure and small development of the ridges for muscular attachment was probably that of a woman. The condition of the teeth and the thin under jaw indicated a person far advanced in life. The tibiæ were remarkably flattened, having an index of 0.52 and 0.53; the index of the well known tibiae from the River Rough Mound — the flattest yet known from North America— being 0.48, while thirty flat tibiæ from mounds in Kentucky, measured by Wyman, had an average index of 0.60.

Mr. Carr's measurements are: Length of skull, 184 mm.; breadth, 128 mm.; index of breadth, 695. Height of person, 5 ft. 6 in. estimated from the leg bones.

Mr. Putnam hoped that Dr. Fewkes would continue the exploration of the burial place he had described, as the crania of New England Indians were very rare in collections and they were of great importance. The finding of the shell of the box-turtle with the human skeleton was of interest, as he had found several such turtle-shells in the graves of the southern moundbuilders. The condition of the bones, he stated, did not always give an indication of the time which had passed since the burial of the body, as difference of soil, of dryness, or of moisture, and probably a difference in the structure of the bones themselves, caused a great variation in the decay of skeletons.

Mr. Bouvé described the opening of an Indian burial ground at Hingham, on the occasion of the Society's visit to his house, some twenty-five years ago. The skeletons were well preserved, and with them a copper kettle was found, showing that the burial had taken place after the arrival of the whites.

Mr. F. W. Putnam occupied the rest of the evening with an account of his explorations of the ancient mounds and burial places in the Cumberland Valley, Tennessee.

The excavations had been carried on by himself, assisted by Mr. Edwin Curtiss, for over two years, for the benefit of the Peabody Museum at Cambridge. During this time many mounds of various kinds had been thoroughly explored, and several thousand of the singular stone graves of the moundbuilders of Tennessee had been carefully opened. The material obtained from the explorations is now arranged and on exhibition in the Peabody Museum. Mr. Putnam's remarks were illustrated by drawings of several hundred objects obtained from the graves and mounds, particularly to show the great variety of articles of pottery and several large and many unique forms of implements of chipped flint. He also exhibited and explained in detail a map of a walled town of this old nation. This town was situated on the Lindsley estate, in a bend of Spring Creek. The earth embankment, with its accompanying ditch, encircled an area of about twelve acres. Within this enclosure there was one large mound with a flat top, fifteen feet high, one hundred and thirty feet long and ninety feet wide, which was found not to be a burial mound. Another mound near the large one, about fifty feet in diameter, and only a few feet high, contained sixty human skeletons, each in a carefully made stone grave, the graves being arranged in two rows, forming the four sides of a square, and in three layers. From these graves many interesting articles were obtained. The most important discovery he made within the enclosure was that of finding the remains of the houses of the people who lived in this old town. Of them about seventy were traced out, and located on the map by Prof. Buchanan of Lebanon, who made the survey for Mr. Putnam. Under the floors of hard clay which was in places much burnt, Mr. Putnam found the graves of children. As only the bodies of adults had been placed in the one mound devoted to burial, and as nearly every site of a house he explored had from one to four graves of children under the clay floor, he was convinced that it was a regular custom to bury the children in that way. He also found that the children had been undoubtedly treated with affection, as in their small graves were found many of the best pieces of pottery he obtained, and also quantities of shell-beads, several large pearls, and many other objects which were probably the playthings of the little ones while living.[1]

A petition for the formation of a Section of Microscopy, signed by Messrs. S. P. Sharples, Samuel Wells, R. R. Andrews, David Hunt, Jr., and others, was read, and the consent of the Corporate Members present was given to such formation.

General Meeting. December 17, 1879.

Vice-President Mr. S. H. Scudder in the chair. Forty-two persons present.

Mr. F. W. Putnam made a communication on the principles involved in the ornamentation of the pottery of some of the ancient nations of America, with particular reference to that from the Cumberland Valley in Tennessee, and from Nicaragua; illustrating his subject by a fine series of vessels of various shapes, selected from the Peabody Museum of American Archæology and Ethnology.

After a general review of the methods of ornamentation employed by American nations of the past, he showed that, by a study of such large collections as those in the Peabody Museum, the artistic development of the ancient peoples of America was far greater than generally stated by writers; and that the art of ornamentation had, in many instances, risen above the simple patterns made by incised lines, rude stamps, and other early and crude forms. Both in color and plastic work, a realistic art had been produced which had often resulted in conventionalisms of great interest.

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[1] A detailed account of this exploration with many illustrations will be found in the 11th Report of the Peabody Museum.

He also stated that a study of this ancient pottery, with these principles of conventionalism borne in mind, would not only place some of these ancient American nations in a much higher artistic period than formerly supposed, but would also lead to understanding many of the singular ornaments on the ancient vessels, many of which, without this knowledge of the existence of realistic and conventional art, would be looked upon as crude and meaningless attempts at ornament, whereas, as he showed by several series of specimens, the simple knobs arranged symmetrically about a pot or water bottle, were instances of pure conventionalism from realistic forms, and prove that a comparatively high attainment in the decorative art had been reached.

A proper and careful study of the principles involved by this interpretation of the artistic development of the ceramic art in America, he thought, would in time furnish means of making comparisons in regard to the probable connection of one ancient American nation with another, and also an understanding of many of the singular resemblances between widely separated peoples. Still, he said, the whole subject was yet in its infancy, and the connection of one ancient people with another in America, can at present only be suggested from very unsatisfactory data.

Remarks were made on the subject by Messrs. Scudder, Hyatt, and Austin.

The petition for the formation of a Section of Microscopy presented at the last meeting, was read a second time, in accordance with the By-Laws, and received the final assent of the Corporate Members present.

General Meeting. January 7, 1880.

The President, Mr. T. T. Bouvé, in the chair. Sixty persons present.

The following gentlemen were elected Associate Members: Messrs. Charles H. Osgood, D.D.S., of Newton, and Jas. R. Nichols, M.D., of Haverhill, Alfred F. Holt, M.D., Frederic

Gardiner, Jr., of Cambridge, Stephen G. Deblois, T. W. B. Clark, John Ritchie, Jr., Joseph Redfearn, M.D., Frank Billings, M.D., Harold Chessman Childs, and Prof. Chas. R. Cross, of Boston.

The following papers were read:

CATALOGUE OF THE HUMMING-BIRDS (TROCHILIDAE) IN THE MUSEUM OF THE BOSTON SOCIETY OF NATURAL HISTORY.[1]

BY THOMAS M. BREWER, M.D.

The following catalogue of the mounted specimens of the interesting family Trochilidae has been in the course of preparation for more than a year, and its publication has been delayed, at first in order to have the aid of Mr. D. G. Elliot's Synopsis of this family, and, since then, with the view of including the additional species recently added to the collection. During this period the original number of 180 species has become 221.

In the almost interminable task of identifying unfamiliar or doubtful specimens the work would have been impossible but for the aid received from the courtesy and experience of Geo. N. Lawrence, Esq., of New York, who has most kindly and faithfully examined and passed upon a large proportion of these identifications.

This catalogue follows the classification of Mr. Elliot's Synopsis, and the names are given in the same order of genera and species. To the name of each species we have added the corresponding number given by Mr. Elliot to his genera and also that to his species. The former are indicated by Roman numerals, the latter by the Arabic.

The nomenclature is identical with that of Mr. Elliot's Synopsis, with three exceptions. We venture to retain the name of *Amazilia cerviniventris* believing *A. yucatanensis* of Cabot to be a distinct species. And we prefer to follow Henshaw in regard to *Selasphorus alleni* and *S. rufus.* The specific peculiarities and distribution of these two closely allied species are greatly in need of more light. What we prefer to call *S. rufus* is, without doubt the more northern species, our examples being from Washington Territory and northern California. All of the La Fresnaye examples in the Society's collection marked as *rufus*, are apparently from Mexico, and are the *S. alleni* of Henshaw.

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[1] This list has been in type for some months and was revised by the late Dr. Brewer himself, who, however, intended a final revision, now unfortunately impossible.

1. **Eutoxeres aquila** Reichenbach. (I–1.) Hab., Costa Rica (eastern side), Veragua, Columbia.

1, sex and locality not stated. 1 ♂, locality not given.

2. **Rhamphodon naevius** Reich. (II–1.) Hab., south-eastern Brazil.

1 ♂, South Brazil, La Fresnaye; 3 ♂, Brazil; 1 ♀, Brazil; 1, C. L. Flint, sex and locality not stated.

3. **Glaucis hirsuta** Boie. (IV–1.) Hab., Costa Rica to Rio de Janeiro, Tobago, Trinidad.

3, sex and locality not stated; 1 ♀, locality not given; 1 ♂, locality not known; 1 ♀, New Grenada; 2 ♂, Brazil; 1 ♂, Guiana.

4. **Glaucis antoniae** Muls. (IV–3.) Hab., Cayenne.

1 ♂, Cayenne.

5. **Glaucis ruckeri** Gould. (IV–6.) Hab., Cayenne.

1 ♀, Cayenne.

6. **Phaeoptila sordida** Gould. (VI–1.) Hab., Mexico.

2, sex and locality not stated.

7. **Phaethornis bourcieri** Gray. (VII–1.) Hab., Pebas, Peru, Marabitanas.

2 ♀, Guiana.

8. **Phaethornis yaruqui** Gould. (VII–3.) Hab., Ecuador.

1 ♀, locality not stated ; 1, sex and locality not given ; 1 ♂, 1 ♀, Quito, Prof. Hopkins.

9. **Phaethornis guyi** Gray. (VII–4.) Hab., Trinidad, Venezuela, Eastern Peru.

1 ♂, locality not stated ; 1 ♀, Bogota ; 1 ♂, New Granada ; 1, sex and locality not give.

10. **Phaethornis emiliae** Bonaparte. (VII–5.) Hab., Costa Rica, Veragua, Columbia.

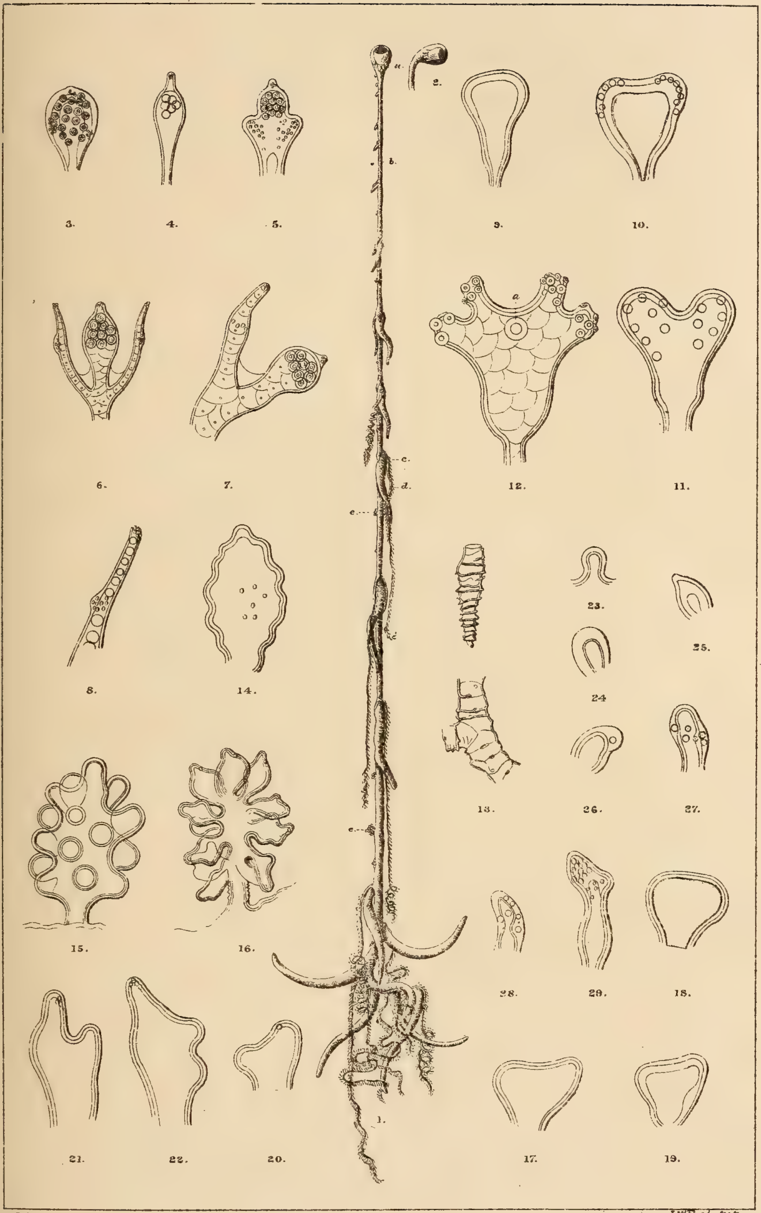
1 ♂, Cayenne ; 1, ♂ Guiana ; 1 ♂, Bogota, Dr. Bryant.

11. **Phaethornis augusti** Reich. (VII–6.) Hab., Venezuela, Columbia.

1 ♂, 1 ♀, Central America. 1, sex and locality not stated.

12. **Phaethornis pretrii** Gray. (VII–7.) Hab., Minas Geraes, Bahia, Brazil.

2 ♂, Brazil; 1 ♀, locality not stated ; 2, sex and locality unknown.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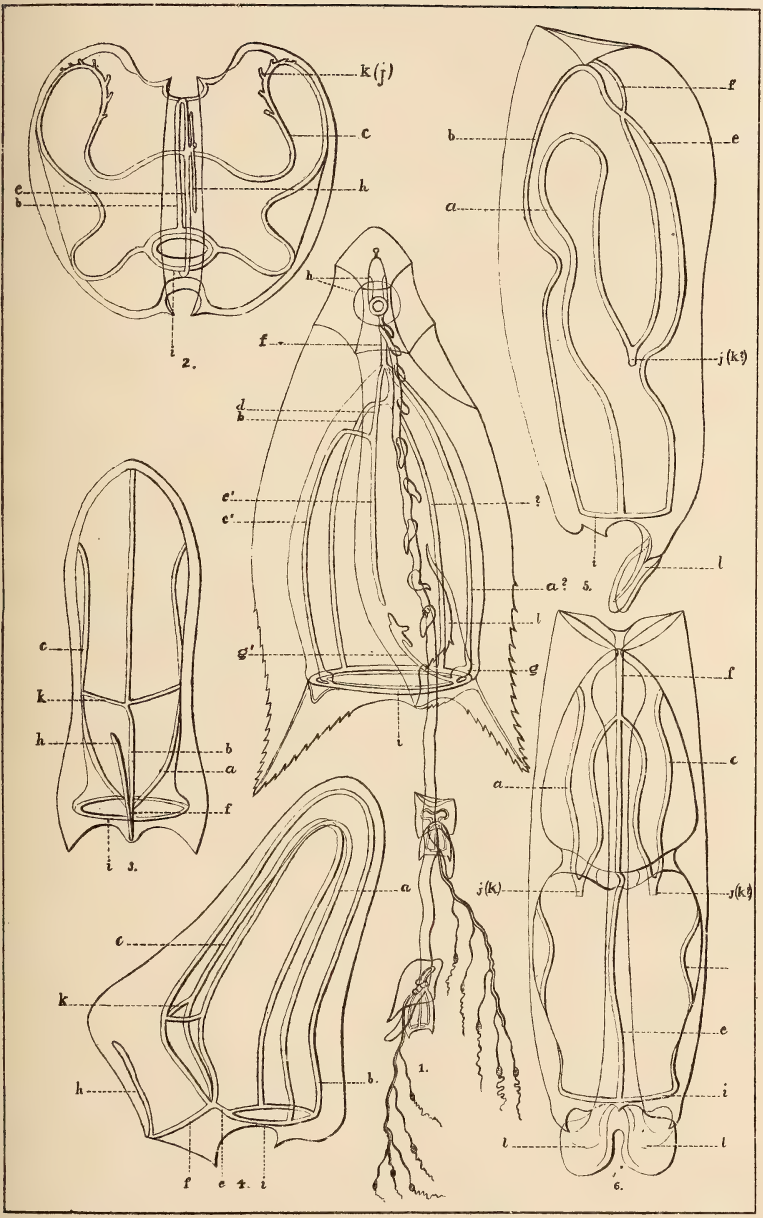
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PROCEEDINGS

OF THE

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VOL. XX.

PART IV. JANUARY, 1880 — APRIL 1880.

BOSTON:
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13. Phaethornis superciliosus Swainson. (VII–8.) Hab., Guiana, Brazil, Columbia, Ecuador and Peru.

1 ♂, Guiana, La Fresnaye; 2, Brazil, La Fresnaye; 1 ♂, Guiana, Dr. Cragin; 3 ♀, Guiana; 2 ♂, Guiana; 1, sex and locality not stated; 1 ♂, 1 ♀, locality not given.

14. Phaethornis longirostris Cab. & Hein. (VII–9.) Hab., Central Am., the Magdalena, W. Ecuador.

1 ♀, locality not stated; 1 ♂, 1 ♀, Guatemala.

15. Phaethornis anthophilus Gray. (VII–12.) Hab., Upper Magdalena, Tibacuy, Venezuela.

1, Ecuador; 1 ♂, Magdalena Valley; 1 ♀, New Granada; 1, sex and locality unknown.

16. Phaethornis eurynome Gray. (VII–13.) Hab., Brazil, southern portion.

1, Brazil, T. R. Peale; 1, Dr. Cragin; 1 ♂, 1 ♀, Rio de Janeiro; 2, sex and locality not given.

17. Phaethornis squalidus Reich. (VII–14.) Hab., Southern Brazil.

1 ♂, 1 ♀, Peru.

18. Phaethornis longuemareus Gray. (VII–15.) Hab., Guiana, Trinidad.

1, Brazil, T. R. Peale; 1 ♂, Rio de Janeiro; 1 ♂, Brazil, 3, sex and locality not indicated.

19. Phaethornis adolphi Gould. (VII–16.) Hab., Mexico and Central America.

1, sex not given, Brazil, La Fresnaye; 3, sex and locality not indicated.

20. Phaethornis griseigularis Gould. (VII–17.) Hab., Columbia.

2 ♂, 2 ♀, locality not given; 3, sex and locality not indicated.

21. Phaethornis striigularis Gould. (VII–18.) Hab., Columbia and Ecuador.

1, sex not given, Rio Napo; 1 ♂, interior of Brazil.

22. Phaethornis pygmaeus Bonaparte. (VII–20.) Hab., Guiana, Brazil.

1 ♂, Brazil, T. R. Peale; 2 ♀, 1 ♂, locality not given.

23. Eupetomena macroura Bon. (VIII–1.) Hab., Cayenne, Brazil.

1 ♂, Guiana, La Fresnaye; 1 juv. ♂, Bahia; 1 ♂, Minas Geraes; 1 ♂, no locality; 4, sex and locality unknown.

24. Sphenoproctus pampa Gould. (IX–1.) Hab., Guatemala.

3 ♀, locality not stated; 1 ♂, 1 ♀, Guatemala.

25. Sphenoproctus curvipennis Gould. (IX–2.) Hab., Mexico.

1, sex and locality not given, La Fresnaye. 1 ♂, Potrero, Mexico; 1 ♀, Xalapa, Mexico, Dr. Bryant.

26. Campylopterus largipennis Cab. & Hein. (X–1.) Hab., Guiana.

1 ♂, Cayenne, La Fresnaye; 1 ♀, Tobago, La Fresnaye; 1 juv. Cayenne, Benjamin; 3 ♂, 1 ♀, Cayenne.

27. Campylopterus rufus Lesson. (X–3.) Hab. Guatemala.

1 ♀, Guatemala.

28. Campylopterus lazulus Bon. (X–5.) Hab., Venezuela, Columbia, Ecuador.

1 ♂, 1 ♀, Jamaica, La Fresnaye; 2 ♂, Bogota; 1 juv., 1 ♀, New Granada.

29. Campylopterus hemileucurus Cab. & Hein. (X–6.) Hab., Mexico to Veragua.

1 ♂, locality not given, La Fresnaye; 1 ♂, Cordova, Mexico; 1 ♀, Jalapa; 1 ♂, S. A., La Fresnaye; 2 ♂, locality not indicated.

30. Campylopterus ensipennis Lesson. (X–7.) Hab., Tobago, Venezuela.

1 ♀, Antilles, La Fresnaye; 1 ♂, Antilles; 2, sex and locality not indicated.

31. Aphantochroa cirrochloris Gould. (XI–2.) Hab., Brazil.

2 ♂, 1 ♀, Brazil.

32. Caeligena clemenciae Lesson. (XII–1.) Hab., Mexico.

1 ♂, Mexico, La Fresnaye; 2 ♂, 1 ♀, Mexico.

33. Caeligena henrici Cab. & Hein. (XII–2.) Hab., Guatemala.

1 ♂, Guatemala, La Fresnaye; 2 ♂, 1 ♀, 1 ♂ juv., locality not given; 1 ♀, Xalapa, Dr. Bryant.

34. Caeligena viridipallens Bourc. & Muls. (XII–3.) Hab., Guatemala.

2 ♂, Mexico; 2, sex and locality not stated.

35. Lamprolaema rhami Reich. (XIII–1.) Hab., Mexico, Guatemala.

2 ♂, Mexico, La Fresnaye; 4, sex and locality not stated.

36. Oreotrochilus pichincha Bon. (XV–1.) Hab., Ecuador, volcanoes of Pichincha and Cotopaxi.

1 ♂, Mt. Pichincha, La Fresnaye ; 4 ♂, Ecuador ; 2 ♀, Ecuador.

37. Oreotrochilus chimborazo Gould. (XV–2.) Hab., Ecuador, volcano of Chimborazo.

1 ♂, 1 ♀, locality not stated ; 1 ♂, Ecuador, Prof. Orton.

38. Oreotrochilus estellae Gould. (XV–3.) Hab., Bolivia, Peru.

1 ♂, 1 ♀, Lake Titicaca, Peru, S. W. Garman.

39. Oreotrochilus leucopleurus Gould. (XV–4.) Hab., Chili.

1 ♀, Chili, Lieut. Gilliss ; 1 ♂, Chili.

40. Lampornis violicauda Elliot. (XVI–1.) Hab., Brazil, Venezuela, Guiana, Panama, Columbia.

1 ♂, Surinam, Dr. Cragin ; 1 ♂ juv., Dr. Cragin ; 2 ♂, 1 ♀, Bogota ; 1 ♂ juv., Columbia ; 1 ♀, Antilles, La Fresnaye.

41. Lampornis mango Gosse. (XVI–2.) Hab., Jamaica.

1 ♂, Florida, La Fresnaye ; 1 ♂, Jamaica ; 1 ♂, Jamaica, Dr. Bryant.

42. Lampornis prevosti Gould. (XVI–3.) Hab., Mexico and Central America to Costa Rica.

1 ♂, Venezuela; 1 ♀, locality not given.

43. Lampornis viridis Gould. (XVI–4.) Hab., Porto Rico.

1 ♂, Porto Rico, Bryant.

44. Lampornis gramineus Gould. (XVI–6.) Hab., Guiana, Venezuela.

1 ♂, Guiana, La Fresnaye; 2 ♀, 2 ♂, 1 juv., locality not given; 1 ♂, 1 juv., Surinam, Dr. Cragin; 1 ♂, St. Domingo, La Fresnaye.

45. Lampornis dominicus Elliot. (XVI–8.) Hab., St. Thomas, St. Domingo, Porto Rico.

1 ♂, Hayti ; 1 ♀, St. Domingo; 1 ♂, locality not given; 1 ♀, 1 ♂, Porto Rico.

46. Eulampis holosericeus Gould. (XVII–1.) Hab., St. Thomas, St. Croix, Martinique, Dominica, Santa Lucia.

1 ♂, Caribbee islands, La Fresnaye; 2 ♂, Martinique ; 1 ♂ juv., locality not given.

47. Eulampis jugularis Gould. (XVII–2.) Hab., Nevis, Martinique, Dominica, Santa Lucia.

1 ♂, Guiana, La Fresnaye; 3 ♂, locality not given.

48. Lafresnaya flavicaudata Reich. (XVIII–1.) Hab., Columbia.

1 ♂, 1 ♀, Columbia, La Fresnaye; 2 ♂, 2 ♀, Santa Fé de Bogota.

49. Lafresnaya gayi Bon. (XVIII–2.) Hab., Venezuela and Ecuador.

2 ♂, 1 ♀, Ecuador; 1 ♂, Ecuador.

50. Chalybura buffoni Reich. (XIX–1.) Hab., Venezuela and Columbia.

1 ♂, 2 ♀, locality not given; 1 ♂, Columbia, Dr. Heermann.

51. Chalybura caeruleiventris Cab. and Hein. (XIX–5.) Hab., Columbia.

1 ♂, 1 ♂ juv., locality not given.

52. Florisuga mellivora Bon. (XX–1.) Hab., Central America, Columbia, Peru, Tobago, Trinidad, Venezuela, Guiana, etc.

2 ♂, 2 ♀, Bogota; 1 ♂, 1 juv., Surinam, Dr. Cragin; 1 ♂, 5 ♀, 1 juv., Cayenne; 1 ♀, Cayenne, La Fresnaye; 1 ♂, Guiana, La Fresnaye.

53. Florisuga fusca Reich. (XX–2.) Hab., Brazil.

1 ♂, Brazil, La Fresnaye; 1 ♂, Brazil, T. R. Peale; 1 ♀, Brazil; 3, sex and locality not given.

54. Petasophora anais Gould. (XXI–1.) Hab., Venezuela, Columbia, Ecuador, Peru, and Bolivia.

1 ♂, Columbia, La Fresnaye; 2 ♂, Bogota; 1 ♂, 1 ♀, 1 juv., locality not indicated.

55. Petasophora thalassina Gould. (XXI–2.) Hab., Mexico and Guatemala.

1 ♂, Mexico, La Fresnaye; 3 ♂, 2 ♀, Mexico.

56. Petasophora cyanotis Bon. (XXI–3.) Hab., Costa Rica, Veragua, Venezuela, Columbia, Ecuador, Peru.

1 ♂, Venezuela; 1 ♂, Ecuador; 1 ♂, 1 ♀, locality not stated.

57. Petasophora serrirostris Bon. (XXI–5.) Hab., Brazil, Bolivia.

1 ♂, Brazil, La Fresnaye; 2 ♂, 1 ♀, Dr. Reinwardt; 1 ♂, 1 ♀, Brazil, T. R. Peale; 2 ♀, Brazil; 1 ♂, Surinam, Dr. Cragin; 1 ♂, locality not stated.

58. Petasophora delphinae Bon. (XXI–6.) Hab., Trinidad, Central America, Guiana, Venezuela, Peru, Columbia, Ecuador.

1 ♂, Columbia, La Fresnaye; 1 ♀, Bogota; 1 juv., Caracas· 2 ♂, 2 ♀, locality not stated.

59. Panoplites jardini Gould. (xxii–1.) Hab., Ecuador.

1 ♂, Ecuador, Dr. Bryant.

60. Panoplites flavescens Gould. (xxii–2.) Hab., Columbia, Ecuador.

2 ♂, 2 ♀, Bogota.

61. Phaeolaema rubinoides Reich. (xxiii–1.) Hab., Columbia.

2, sex not indicated, New Grenada; 1 ♂, Bogota, Dr. Bryant.

62. Phaeolaema aequatorialis Gould. (xxiii–2.) Hab., Ecuador.

1, sex unknown, Ecuador.

63. Clytolaema rubinea Gould. (xxiv–1.) Hab., Brazil.

1 ♀, South Brazil, La Fresnaye; 1 ♀, Brazil, T. R. Peale; 1 ♂ juv., 2 ♀, Brazil; 2 ♂, 1 ♀, locality unknown.

64. Eugenes fulgens Gould. (xxvii–1.) Hab., Texas, Mexico, Guatemala.

1 ♂, Mexico, La Fresnaye; 3 ♂, 2 ♀, Mexico.

65. Heliodoxa jacula Gould. (xxxi–1.) Hab., Costa Rica, Veragua, Columbia.

1 ♂, Bogota; 1 ♂, Napo.

66. Heliodoxa leadbeateri Gould. (xxxi–3.) Hab., Venezuela, Columbia, Peru, Bolivia.

2 ♂, 1 ♀, Venezuela; 1 ♂, 1 ♀, Columbia; 1 ♀, Bogota, Dr. Bryant.

67. Pterophanes temminckii Gould. (xxxii–1.) Hab., Columbia, Ecuador, Peru, Bolivia.

1 ♂, Bogota, La Fresnaye; 1 ♀, 3 ♂, Bogota.

68. Patagona gigas Gray. (xxxiii–1.) Hab., West coast of S. A. from Ecuador to Chili.

1 ♂, 1 ♀, Chili, La Fresnaye; 1 ♂, Chili; 2 ♂, 1 ♀, Peru; 1 ♀, Dr. Cragin; 1 ♂, locality not given.

69. Docimastes ensiferus Gould. (xxxiv–1.) Hab., Columbia, Ecuador, Peru.

1 ♂, 1 ♀, Bogota, La Fresnaye; 1 ♂, juv., Ecuador; 2 ♂, 1 ♀, locality not given.

70. Helianthea typica Gould. (xxxvi–2.) Hab., Columbia.

1 ♂, 2 ♀, La Fresnaye; 2 ♂, 2 ♀, locality not given.

71. Helianthea bonapartii Gould. (xxxvi–3.) Hab., Columbia.

1 ♂, Bogota, La Fresnaye; 2 ♂, 3 ♀, locality not designated.

72. **Helianthea lutitiae** Gould. (XXXVI–5.) Hab., Ecuador, Volcano of Puracé, near Popayan.

2 ♂, 1 ♀, Ecuador.

73. **Bourcieria fulgidigula** Gould. (XXXVII–4.) Hab., Ecuador.

3, sex and locality not stated.

74. **Bourcieria torquata** Gould. (XXXVII–5.) Hab., Columbia.

1 ♂, Bogota; 1 ♂, juv., Ecuador; 1 ♂, Popayan; 1 ♂, 2 ♀, locality not given.

75. **Bourcieria wilsoni** Bon. (XXXVII–7.) Hab., Columbia, Equador.

2 ♂, locality not given.

76. **Bourcieria prunelli** Bon. (XXXVII–10.) Hab., Columbia.

1 ♀, Bogota; 2 ♂, Columbia.

77. **Bourcieria columbiana** Elliot. (XXXVII–12.) Hab., Columbia.

1 ♂, 2 ♀, Bogota.

78. **Hemistephania johannae** Reich. (XXXVIII–1.) Hab., Columbia.

1 ♂, Bogota; 1 ♂, locality not given.

79. **Hemistephania ludoviciae** Reich. (XXXVIII–2.) Hab., Columbia.

2, sex and locality not given.

80. **Hemistephania rectirostris** Elliot. (XXXVIII–3.) Hab., Ecuador.

1 ♂, Ecuador, Dr. Bryant.

81. **Floricola longirostris** Elliot. (XXXIX–1.) Hab., Mexico, Central America, Trinidad, Venezuela, Guiana, Columbia, etc.

1 ♂, Cayenne, La Fresnaye; 1 ♂, Trinidad, La Fresnaye; 1 ♂, Columbia; 1 ♂, Bogota, Dr. Bryant.

82. **Floricola constanti** Elliot. (XXXIX–3.) Hab., Guatemala and Costa Rica.

1 ♂, locality not given; 1 ♀, Guatemala.

83. **Lepidolarynx mesoleucus** Reich. (XL–1.) Hab., Brazil.

1 ♂, 1 ♂ juv., Brazil; 1 ♂, 4 ♀, locality not known.

84. **Heliomaster furcifer** Elliot. (XLI–1.) Hab., Brazil and Paraguay.

1 ♂, 1 ♀, locality not given.

85. **Heliotrypha exortis** Elliot. (XLII–2.) Hab., Columbia, Ecuador.

1 ♂, Bogota, La Fresnaye; 1 ♂, 1 ♀, 1 ♂ juv., Bogota; 1 ♂, 1 ♀, locality not stated.

86. **Heliangelus clarissae** Bon. (XLIII 1.) Hab., Columbia.

2 ♂, Columbia, La Fresnaye; 2 ♂, 1 ♀, Bogota; 2 ♀, 1 juv., New Grenada.

87. **Heliangelus strophianus** Bon. (XLIII–2.) Hab., Ecuador.

4 ♂, Ecuador.

88. **Urosticte benjamini** Gould. (XLIV–2.) Hab., Ecuador.

1 ♂, locality not given. 1 ♀, 1 ♂, Ecuador, Prof. Orton.

89. **Eustephanus galeritus** Reich. (XLV–1.) Hab., Chili, Juan Fernandez.

1 ♂, Juan Fernandez, La Fresnaye; 1 ♀, Juan Fernandez; 1 ♂, Terra del Fuego, La Fresnaye; 1 ♀, Chili, T. R. Peale, 1 ♂, 1 ♀, Chili, M. Vattemare; 2 ♂, 2 ♀, locality not given.

90. **Eustephanus fernandensis** Reich. (XLV–2.) Hab., island of Juan Fernandez.

1 ♂, Juan Fernandez, La Fresnaye; 1 ♂, 1 ♀, Juan Fernandez.

91. **Topaza pella** Gray. (XLVI–1.) Hab., Cayenne, Trinidad, Brazil, Amazon.

1 ♀, Surinam, La Fresnaye; 1 ♀, Trinidad, La Fresnaye; 1 ♂, Guiana, La Fresnaye; 1 ♂, Guiana; 1 ♀, 1 ♂, Surinam, Dr. Cragin, 1 ♂, 3 ♀, locality not given.

92. **Aithurus polytmus** Cab. and Hein. (XLVII–1.) Hab., Jamaica.

1 ♂, Jamaica, La Fresnaye; 1 ♂, 1 ♀, Jamaica, Dr. Bryant; 1 ♂ juv., 1 ♀, Jamaica.

93. **Thalurania glaucopis** Gould. (XLIX–1.) Hab., Brazil.

1 ♂, Brazil, La Fresnaye; 1 ♀, Brazil, T. R. Peale; 4 ♂, 2 ♀, locality not given.

94. **Thalurania columbica** Gould. (XLIX–2.) Hab., Costa Rica, Veragua, Panama, Columbia.

1 ♂, 1 ♀, Bogota; 1 juv., 1 ♀, Bogota, Dr. Bryant; 1 ♂, Panama, Prof. Hopkins.

95. Thalurania furcata Gould. (XLIX 3.) Hab., Guiana.

2 ♂, Brazil, La Fresnaye; 1 ♀, 2 ♂, no locality.

96. Thalurania nigrofasciata Bon. (XLIX–5.) Hab., Ecuador and Peru.

1 ♂, 1 ♀, Napo; 1 ♂, Rio Negro; 3 ♂, locality not given.

97. Thalurania eriphile Bon. (XLIX–9.) Hab., Brazil, Ecuador, Columbia.

1 ♂, 1 ♀, Brazil; 1 ♂, Ecuador; 1 ♂, locality not given.

98. Thalurania bicolor Elliot. (XLIX–11.) Hab., Brazil, island of Dominica.

2 ♂, 2 ♀, Brazil; 1 ♂, Cayenne.

99. Mellisuga minima Bon. (L–1.) Hab., Jamaica, St. Domingo.

1 ♀, Jamaica; 1 ♀, St. Domingo; 1 ♂, St. Domingo, Bryant.

100. Trochilus colubris Linnaeus. (LII–1.) Hab., Eastern North America, Mexico, Central America.

2 ♂, U. S., La Fresnaye; 3 ♀, 1 ♂, locality not given; 1 ♂, 1 ♀, 1 juv., Mass.

101. Trochilus alexandri Bourc. and Muls. (LII–2.) Hab., California and Mexico.

1 ♀, Mexico.

102. Calypte costae Gould. (LIII–1.) Hab., California and Mexico.

1 ♂, California; 1 ♂, Mexico.

103. Calypte annae Gould. (LIII–2.) Hab., Mexico and California.

1 ♂, California, La Fresnaye; 1 ♂, California, Samuels; 2 ♂, 1 ♀, California.

104. Selasphorus platycercus Bon. (LIV–2.) Hab., Guatemala, Mexico, Rocky Mountains to Utah.

1 ♂, Mexico, La Fresnaye; 1 ♂, Guatemala; 3 ♀, locality not known; 1 ♀, Mirador, Mexico, Dr. Bryant.

105. Selasphorus rufus Audubon. *Selasphorus henshawi* Elliot. (LIV–5.) Hab., California to Nootka Sound.

106. Selasphorus alleni Henshaw. *Selasphorus rufus* Elliot. (LIV–7.) Hab., California.

2 ♂, La Fresnaye; 1 juv., 1 ♀, locality not given.

107. Atthis heloisae Reich. (LVI–1.) Hab., Mexico.

1 ♂, Mexico, La Fresnaye; 2 ♂, Guatemala; 3 ♀, locality not known.

108. Stellula calliope Gould. (LVII–1.) Hab., Mexico, California.

1 ♂, California; C. A. Allon.

109. Rhodopis vesper Gould. (LVIII–1.) Hab., Peru.

4 ♂, 1 ♀, 1 juv., Peru.

110. Heliactin cornuta Boie. (LIX–1.) Hab., Brazil.

2 ♂, Brazil, La Fresnaye; 1 ♀, Minas Geraes; 2 ♀, locality not given.

111. Calothorax pulchra Gould. (LX–1.) Hab., Mexico.

1 ♂, locality not stated.

112. Calothorax lucifer Gray. (LX–2.) Hab., Jalapa and Cordova, Mexico.

2 ♂, Mexico, La Fresnaye; 1 ♂, 2 ♀, Mexico.

113. Acestrura mulsanti Gould. (LXI–1.) Hab., Columbia, Ecuador, Peru.

1 ♂, 2 ♀, Bogota.

114. Acestrura heliodori Gould. (LXI–3.) Hab., Venezuela, Columbia.

1 ♂, Bogota, La Fresnaye; 2 ♀, Bogota; 1 ♂, Columbia; 1 ♂, locality unknown.

115. Chaetocercus jourdani Gray. (LXII–1.) Hab., Trinidad.

1 ♂, Trinidad, Dr. Bryant.

116. Chaetocercus rosae Cab. and Hein. (LXII–2.) Hab., Venezuela.

1 ♂, Venezuela, La Fresnaye; 2 ♂, 2 ♀, Caracas.

117. Thaumastura cora Bon. (LXIII–1.) Hab., Peru.

2 ♂, 1 ♀, locality not given.

118. Doricha enicura Reich. (LXIV–1.) Hab., Guatemala.

1 ♂, Brazil, La Fresnaye; 1 ♂, Guatemala; 3 ♀, 2 ♀, locality not known.

119. Doricha elizae Gould. (LXIV–2.) Hab., Mexico.

1 ♂, Jalapa; 1 ♀, locality not known.

120. Doricha evelynae Gould. (LXIV–4.) Hab., Bahamas.

1 ♂, 1 ♀, Nassau, Bahamas, Cory.

121. Doricha lyrura Gould. (LXIV–5.) Hab., Bahamas.

1 ♂, 1 ♀, 1 juv., Bahamas, Bryant.

122. Myrtis fanny Reich. (LXV–1.) Hab., Ecuador and Peru.

1 ♂, locality not given.

123. **Tilmatura duponti** Cab. and Hein. (LXVI–1.) Hab., Guatemala.

2 ♂, 2 ♀, Guatemala.

124. **Calliphlox amethystina** Reich. (LXIX–1.) Hab., Trinidad, Venezuela, Brazil.

2 ♀, Brazil, La Fresnaye; 1 ♂, Brazil, T. R. Peale; 1 ♂, 1 ♀, Guiana; 1 ♂, Brazil; 1 ♀, Surinam, Dr. Cragin; 2 ♂, locality not given.

125. **Lophornis stictolophus** Salvin and Elliot. (LXX–1.) Hab., Venezuela, Columbia, Ecuador.

1 ♂, 1 ♀, locality unknown.

126. **Lophornis ornatus** Gould. (LXX–4.) Hab., Trinidad, Venezuela, Guiana.

1 ♂, Guiana, La Fresnaye; 1 ♂, 2 ♀, Cayenne; 1 ♂, Trinidad; 1 ♂, locality unknown.

127. **Lophornis magnificus** Gould. (LXX–6.) Hab., Brazil.

1 ♂, Brazil, La Fresnaye; 2 ♂, 2 ♀, 1 juv., locality not stated.

128. **Lophornis helenae** Reich. (LXX–7.) Hab., Mexico, Guatemala, Costa Rica.

3 ♂, 1 ♀, Coban.

129. **Lophornis chalybea** Reich. (LXX–10.) Hab., Brazil.

1 ♂, St. Catharine, Brazil; 2 ♂, 2 ♀, locality not given.

130. **Gouldia popelairii** Bon. (LXXI–1.) Hab., Columbia, Ecuador, Peru.

1 ♂ juv., locality not given; 3, sex and locality not stated.

131. **Gouldia langsdorffi** Bon. (LXXI–2.) Hab., Brazil, Upper Amazon, Peru.

4 ♂, Brazil.

132. **Gouldia conversi** Bon. (LXXI–3.) Hab., Columbia.

1 ♂, New Grenada.

133. **Discura longicauda** Reich. (LXXII–1.) Hab., Guiana, Brazil.

1 ♂, Guiana, La Fresnaye; 1 ♂, 1 ♂ juv., 2 ♀, Cayenne; 1 juv., Surinam, P. Benjamin.

134. **Steganura underwoodi** Reich. (LXXIII–1.) Hab., Columbia, Venezuela.

1 ♂, Bogota, La Fresnaye; 2 ♂, New Grenada; 2 ♀, Bogota; 1 ♂, 3 ♀, locality not given.

135. Steganura melananthera Reich. (LXXIII–2.) Hab., Ecuador.

1 juv. ♀, Quito, Ecuador, Dr. Bryant.

136. Lesbia gouldi Reich. (LXXV–1.) Hab., Columbia, Ecuador, Peru.

1 ♂, 1 ♀, Bogota, La Fresnaye; 3 ♂, 1 ♀, Bogota.

137. Lesbia nuna Gould. (LXXV–2.) Hab., Peru.

1 ♂, Peru.

138. Lesbia amaryllis Reich. (LXXV–4.) Hab., Columbia, Ecuador.

1 ♂, 2 ♀, Bogota; 2 ♂, locality not given.

139. Cynanthus forficatus Bon. (LXXVII–1). Hab., Venezuela, Columbia, Ecuador.

1 ♂, 1 ♂ juv., Venezuela; 4 ♀ juv., locality not given.

140. Sappho sparganura Reich. (LXXVIII–1.) Hab., Bolivia, Argentine Republic.

1 ♂, Bolivia, La Fresnaye; 1 ♂, Peru, La Fresnaye; 1 ♂, 3 ♀, locality not given.

141. Oxypogon guerini Gould. (LXXIX–2.) Hab., Columbia.

1 ♂, Columbia, La Fresnaye; 1 ♂, Venezuela; 1 ♂, Columbia; 1 ♀, locality not given.

142. Rhamphomicron heteropogon Bon. (LXXXI–2.) Hab., Columbia.

1 ♂, Columbia, La Fresnaye; 1 ♂, 1 ♀, 1 juv., Bogota.

143. Ramphomicron stanleyi Gould. (LXXXI–4.) Hab., Ecuador, Peru.

1 ♂, 1 ♂ juv., Ecuador.

144. Ramphomicron microrhynchum Bon. (LXXXI–6.) Hab., Columbia, Ecuador.

1 ♂, Bogota, La Fresnaye; 1 ♀, Ecuador, La Fresnaye; 3 ♀, 1 ♂, 1 juv., Bogota.

145. Avocettinus eurypterus Bon. (LXXXII–1.) Hab., Columbia.

1 ♀, locality not stated.

146. Avocettula recurvirostris Reich. (LXXXIII–1.) Hab., Guiana.

1 ♂, La Fresnaye; 2 ♂, Guiana; 1 ♀, Demerara.

147. Metallura tyrianthina Bon. (LXXXIV–8.) Hab., Venezuela, Columbia, Ecuador, Peru.

1 ♂, Bogota, La Fresnaye; 2 ♂, Ecuador; 1 ♂, 1 ♀, locality not stated.

148. Chrysuronia aenone Bon. (LXXXV–2.) Hab., Venezuela, Columbia, Ecuador.

1 ♂, Trinidad, La Fresnaye; 1 ♂, Napo; 3 ♂, 2 ♀, locality not given.

149. Chrysuronia eliciae Bon. (LXXXV–4.) Hab., Guatemala to Chiriqui.

1 ♂, Guatemala; 2 ♂, locality not given.

150. Augastes lumachellus Bon. (LXXXVI–1.) Hab., Brazil, Bahia.

1 ♂, Bahia, La Fresnaye; 2 ♂, 1 ♀, locality not given.

151. Augastes superbus Bon. (LXXXVI–2.) Hab., Brazil.

1 ♂, Brazil; 1 ♂, 2 ♀, locality not given.

152. Schistes geoffroyi Gould. (LXXXVIII–2.) Hab., Ecuador.

1 ♂, 1 juv., 2 ♀, Bogota.

153. Heliothrix auritus Boie. (LXXXIX–1.) Hab., Peru, Ecuador, Columbia, Venezuela, Guiana, Northern Brazil.

2 ♂, 1 ♀, Cayenne; 1 ♀, Brazil, T. R. Peale.

154. Heliothrix auriculatus Gray. (LXXXIX–2.) Hab., Southern Brazil.

2 ♂, 2 ♀, Southern Brazil.

155. Heliothrix barroti Gray. (LXXXIX–3.) Hab., Central America, Columbia, Ecuador.

1 ♂, locality not given.

156. Chrysolampis moschitus Boie. (XC–1.) Hab., Trinidad, Venezuela, Guiana, Brazil, Amazonian Valley, Columbia.

1 ♂, Brazil, La Fresnaye; 1 ♂, 1 ♀, Antilles, La Fresnaye; 3 ♂, 3 ♀, locality not given; 1 ♂, Brazil, T. R. Peale; 1 ♀, Trinidad; 1 ♂, Bogota; 2 ♀, Cayenne; 1 ♂, 1 ♀, Brazil.

157. Bellona cristata Muls. (XCI–1.) Hab., St. Vincent, Barbadoes, Martinique, St. Lucia.

1 ♀, Martinique; 2 ♀, St. George, Grenada, P. Gellinan.

158. Bellona exilis Muls. (XCI–2.) Hab., Dominica, Nevis, St. Thomas, St. Croix.

2 ♂, 1 ♀, Martinique.

159. **Cephalolepis delalandi** Cab. and Hein. (XCII–1.) Hab., Southern Brazil.

2 ♂, Brazil, La Fresnaye; 1 juv., Brazil; 2 ♂, 2 ♀, locality not given; 1 ♂, Brazil, T. R. Peale.

160. **Cephalolepis loddigesi** Gould. (XCII–2.) Hab., South-Eastern Brazil.

1 ♂, Brazil, C. L. Flint.

161. **Adelomyia melanogenys** Gould. (XCIII–4.) Hab., Venezuela, Columbia, Ecuador, Peru.

1 ♂, 1 ♀, 1 juv., locality not known.

162. **Abeillia typica** Elliot. (XCV–1.) Hab., Mexico to Veragua.

1 ♂, juv., Mexico; 1 ♂, 2 ♀, Guatemala.

163. **Klais guimeti** Reich. (XCVI–1.) Hab., Costa Rica, Veragua, Venezuela, Columbia.

2 ♂, 1 ♀, Venezuela.

164. **Aglaeactis cupripennis** Muls. (XCVII–1.) Hab., Columbia, Ecuador, Peru.

1 ♂, Columbia, La Fresnaye; 1 ♂, Quito; 1 ♂, 1 ♀, Ecuador; 2 ♂, locality unknown.

165. **Eriocnemis aureliae** Reich. (XCVIII–3.) Hab., Columbia and Ecuador.

1 ♂, Bogota, La Fresnaye; 2 ♂, 2 ♀, locality not given.

166. **Eriocnemis lugens** Bon. (XCVIII–5.) Hab., Ecuador.

1 ♂, Ecuador.

167. **Eriocnemis alinae** Reich. (XCVIII–6.) Hab., Columbia.

3 ♂, 1 ♀, 1 juv., Columbia.

168. **Eriocnemis luciani** Reich. (XCVIII–9.) Hab., Ecuador.

2 ♂, 2 ♀, Ecuador.

169. **Eriocnemis cupreiventris** Reich. (XCVIII–10.) Hab., Columbia.

1 ♂, Columbia, La Fresnaye; 1 ♂, 3 ♀, Columbia.

170. **Eriocnemis vestita** Reich. (XCVIII–14.) Hab., Venezuela and Columbia.

2 ♂, Bogota, La Fresnaye; 1 ♂ juv., locality unknown; 1 ♂, 1 ♀, Venezuela.

171. **Panterpe insignis** Cab. and Hein. (XCIX–1.) Hab., Costa Rica.

1 ♂, Costa Rica, Dr. Bryant.

172. **Uranomitra quadricolor** Reich. (c–1.) Hab., Northern Mexico.

2, sex and locality not given.

173. **Uranomitra cyanocephala** Reich. (c–4.) Hab., Mexico, Guatemala, Honduras.

3, sex and locality not known; 1 ♂, 1 ♀, Guatemala, Dr. Bryant.

174. **Uranomitra franciae** Reich. (c–6.) Hab., Columbia.

1 ♀, 1 juv., Bogota; 1 ♂, Bogota, Dr. Bryant.

175. **Leucippus chionogaster** Gould. (ci–1.) Hab., Peru, Bolivia.

1 ♂, 1 ♀, Bolivia.

176. **Leucochloris albicollis** Reich. (cii–1.) Hab., Brazil.

3 ♂, Brazil, Dr. Reinwardt; 1 ♂, Brazil, T. R. Peale; 3, sex and locality not given.

177. **Agyrtria niveipectus** Cab. (ciii–1.) Hab., Trinidad, Venezuela, Guiana.

2 ♀, locality not given; 1 ♂, South America, Dr. Heermann.

178. **Agyrtria leucogaster** Reich. (ciii–2.) Hab., Guiana, Brazil.

1 ♀, locality not given; 1 ♂ juv., "Mexico," Dr. Bryant.

179. **Agyrtria milleri** Reich. (ciii–4.) Hab., Columbia.

1 ♀, Rio Negro, Brazil; 1 ♀, New Grenada.

180. **Agyrtria candida** Cab. and Hein. (ciii–5.) Hab., Mexico, Central America.

2 ♀, Guatemala; 1 ♀, Potrero, Mexico, Dr. Bryant; 2, ♂ Guatemala.

181. **Agyrtria brevirostris** Reich. (ciii–7.) Hab., Brazil.

1 ♂, Brazil, T. R. Peale; 2 ♂, Cayenne; 1 ♀, Brazil; 3, sex and locality unknown.

182. **Agyrtria tephrocephala** Elliot. (ciii–13.) Hab. Brazil.

1 ♀, Brazil.

183. **Agyrtria tobaci** Elliot. (ciii–14.) Hab., Tobago, Trinidad, Venezuela, Guiana, Brazil.

1 ♂, locality in doubt.

184. **Agyrtria nitidicauda** Elliot. (ciii–20.) Hab. Guiana.

2 ♂, locality not known.

185. Eupherusa eximia Gould. (CVII–2.) Hab., Guatemala.

2 ♂, Guatemala; 1 ♂, Coban; 1 ♀, Guatemala.

186. Polytmus thaumantias Cab. and Hein. (CVIII–1.) Hab., Trinidad, Venezuela, Brazil.

1 ♂, Brazil, T. R. Peale; 1 ♂, Brazil; 1 ♀, Bogota; 6 ♂, 2 ♀, locality not given.

187. Polytmus viridissimus Elliot. (CVIII–2.) Hab., Guiana, Venezuela.

2 ♂, Brazil, La Fresnaye; 2 ♂, Cayenne; 2 ♂, locality not given.

188. Amazilia pristina Gould. (CIX–1.) Hab., Ecuador, Peru.

1 ♀, locality not given.

189. Amazilia cinnamomea Elliot. (CIX–5.) Hab., Guatemala, Costa Rica.

2, sex and locality not given; 1 ♂, Tehuantepec, Sumichrast; 1 ♀, Pacific coast of Guatemala, Salvin.

190. Amazilia cerviniventris Gould. *Amazilia yucatanensis* Elliot (nec. Cabot). (CIX–7.) Hab., Mexico and S. W. Texas.

1 ♂, locality not given; 1 ♂, 1 ♀, Fort Brown, Texas, Dr. J. C. Merrill.

191. Amazilia fuscicaudata Elliot. (CIX–8.) Hab., Mexico, Central America, Columbia, Ecuador, S. W. Texas.

1 ♂, New Grenada; 1 ♀, Mexico; 1 ♂, 1 ♀, Bogota; 1 ♂, locality uncertain.

192. Amazilia viridiventris Elliot. (CIX–9.) Hab., Columbia.

1 ♂, 1 ♀, locality uncertain; 1 ♂, Jalapa; 1 ♀, Bogota.

193. Amazilia beryllina Gould. (CIX–11.) Hab., Mexico, Columbia?

1 ♂, Jalapa, Mexico; 2 ♂, 1 ♀, locality uncertain; 1 ♂, 1 ♀, Guatemala.

194. Amazilia edwardi Elliot. (CIX–12.) Hab., Panama.

1 ♂, 1 ♀, locality not ascertained.

195. Amazilia mariae Elliot. (CIX–14.) Hab., Guatemala.

2 ♂, Guatemala; 2 ♀, Guatemala.

196. Amazilia erythronota Elliot. (CIX–18.) Hab., Tobago, Trinidad, Venezuela, Columbia.

2 ♂, S. A., La Fresnaye; 1 ♂, Trinidad; 2 ♂, 1 ♀, locality not ascertained.

197. Amazilia feliciae Elliot. (CIX–19.) Hab., Venezuela.

1 ♂, Venezuela; 1 ♂, locality not known.

198. Amazilia sophiae Bon. (CIX–20.) Hab., Costa Rica.

1 ♂, San Jose, Costa Rica, Dr. Bryant.

199. Amazilia cyanifrons Elliot. (CIX–23.) Hab., Columbia.

2 ♂, Bogota; 3 ♂, locality not known.

200. Basilinna leucotis Boie. (CX–1.) Hab., Mexico, Guatemala.

1 ♂, Brazil, La Fresnaye; 1 ♂, Cayenne; 1 ♂, Mexico; 2 ♂, 2 ♀, locality not given.

201. Eucephala grayi Reich. (CXI–1.) Hab., Ecuador.

1 ♂, Popayan, Dr. Bryant.

202. Eucephala caerulea Gould. (CXI–7.) Hab., Trinidad, Venezuela, Guiana, Brazil.

4 ♂, Guiana, La Fresnaye; 1 ♀, La Fresnaye; 1 ♂, Cayenne; 1 ♂, P. Benjamin; 2 ♂, 1 ♀, locality not given.

203. Juliamyia typica Bon. (CXIII–1.) Hab., Panama, Columbia.

4, sex and locality not given.

204. Damophila amabilis Reich. (CXIV–1.) Hab., Costa Rica, Ecuador.

1 ♂, juv., Boca del Toro; 1 ♂, Bogota; 1 ♂, New Grenada.

205. Iache latirostris Elliot. (CXV–1.) Hab., Mexico.

3 ♂, 2 ♀, locality not given.

206. Hylocharis lactea Gray. (CXVI–1.) Hab., Brazil.

2, sex and locality not indicated.

207. Hylocharis sapphirina Gray. (CXVI–2.) Hab., Brazil.

1 juv. ♂, Brazil, La Fresnaye; 1 ♂, 1 ♂ juv., Brazil, Benjamin; 1 ♀, Brazil, T. R. Peale; 3 ♀, locality not given.

208. Hylocharis cyanea Gray. (CXVI–3.) Hab., Brazil.

1 ♂, Brazil, Benjamin; 1 ♂, E. Brazil, La Fresnaye; 1 ♀, T. R. Peale; 1 ♀, Townsend; 2 ♂, 2 ♀, locality unknown.

209. Cyanophaia caeruleigularis Elliot. (CXVII–1.) Hab., Veragua.

1 ♂, Panama, Bryant.

210. Cyanophaia goudoti Elliot. (cxvii–2.) Hab., Columbia.

1 ♂, Columbia; 2 ♂, locality not given. 1 ♂, juv., Bogota, Dr. Bryant.

211. Sporadinus elegans Bon. (cxviii–1.) Hab., Hayti.

1 ♂, St. Domingo.

212. Sporadinus riccordi Bon. (cxviii–2.) Hab., Cuba, Bahamas.

1 ♂, Andros Island, Bahamas, 1879, Cory.

213. Sporadinus maugaei Bon. (cxviii–3.) Hab., Porto Rico.

1 ♂, P [illegible]

214. [illegible] Hab., Mexico, [illegible]

1 [illegible] given.

21[illegible] South-ea[illegible]

1 juv., 2 ♂, [illegible]

216. Chlorost[illegible] Buenos Ayres to Bolivia.

1 ♂ juv., 1 ♀, Bolivia.

217. Chlorostilbon haberlini [illegible] Hab., Panama, Columbia, Venezuela.

2 ♂, Bogota; 1 ♂, 1 ♀, locality not stated. [illegible] Fresnaye.

218. Chlorostilbon angustipennis Gould. (cxi[illegible] Hab., Veragua, Panama, Venezuela, Columbia, Ecuador.

1 ♂, 1 ♀, Panama, Dr. Bryant; 1 ♂, 1 ♀, Columbia, Dr. Heermann.

219. Chlorostilbon atala Gould. (cxix–7.) Hab., Trinidad, Guiana, Amazon.

2 ♂, Ecuador; 2 ♂, locality not given.

220. Chlorostilbon prasinus Elliot. (cxix–8.) Hab., Venezuela, Cayenne, Amazon, Peru.

1 ♂, Rio de Janeiro, La Fresnaye; 1 ♂, Brazil, La Fresnaye; 1 ♂, Brazil, T. R. Peale; 2 ♂, Cayenne; 2 ♂, 1 ♀, locality not given.

221. Panychlora poortmani Cab. and Hein. (cxx–1.) Hab., Columbia.

1 ♂, Columbia, La Fresnaye; 1 ♂, juv., Bogota; 1 ♀, New Grenada; 1 ♀, 2 ♂, locality not given.

Letters from Professors Archibald Geikie of Scotland, and Andrew C. Ramsay, W. Boyd Dawkins and Wm. Henry Flower of England, acknowledging their election as Corresponding Members were [illegible]

[illegible] 12, 1880.

[illegible] persons present.

[illegible] given by the general [illegible]py was formally organized. [illegible] permanent Secretary. It was [illegible] Monday following the first Wednesday of [illegible] 3-4 P. M.

[illegible]. C. S. Minot described the supposed male sexual organs of the eel.

General Meeting. January 21, 1880.

The President, Mr. T. T. Bouvé, in the chair. Sixty-one persons present.

The following papers were read:

THE FELSITES AND THEIR ASSOCIATED ROCKS NORTH OF BOSTON.[1] BY J. S. DILLER.

It is to be greatly regretted that there is no accurate map of Boston and vicinity on a sufficiently large scale to be used to advantage in constructing a geological map. Mr. W. O. Crosby in preparing his contributions to the Geology of Eastern Massachusetts uses a map based on Mr. H. F. Walling's surveys, having a scale of an inch to a mile. It is not sufficiently large to allow the ordinary basaltic dikes and the smaller areas of some of the other rocks to be represented.

In my work I have used D. G. Beer's maps of the towns about Boston and reduced them all to the scale of a thousand feet to an inch. These maps, like others of this region, when compared with the accurate work of some of the civil engineers of the towns mapped, are found to be very erroneous, but they are, on the whole, the best maps that could be obtained.

The felsites occur in Medford, Malden, Melrose, Wakefield, Saugus, Lynn, and Marblehead Neck. Only a portion of these towns has already been mapped, and several years will be required to complete the work.

I am greatly indebted to Mr. W. O. Crosby for an advance sheet of his "Geological Map of Boston and Vicinity." This map has been of very great service to me in the field by showing the general distribution of the formations. On account of the many errors which it contains the "Centennial Map" should be supplanted as quickly as possible by another map giving accurately the detailed distribution of the various rocks.

The rocks associated with the felsites are diorite, a stratified group consisting of quartzite and slates, granite, breccia, conglomerate slate, diabase and melaphyre. These rocks have not been studied to any considerable distance from their junction with the felsite. It has been thought best to describe them in their order of geological succession rather than describe the felsites first and then the older and younger rocks. The order of formation has not been definitely determined in all cases, but ere long we hope to observe the facts that will indicate clearly the position of each rock in the chronological series.

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[1] Last year I took a course of instruction in Microscopic Lithology under Mr. M. E. Wadsworth at the Museum of Comparative Zoology in Cambridge. He assigned to me the Malden Highlands as the region, the lithology and geology of which I was to unravel. It was soon found advisable to enlarge the field so as to include all the felsites north of Boston. This paper is merely a preliminary report upon some of the work already accomplished, and the general statements which it contains refer only to the region under consideration. In a few years I hope to present a complete report upon the field work as well as upon the microscopic and some of the chemical characters of the rocks studied.

STRATIFIED GROUP.

In Melrose and Saugus the felsite is associated with a group of rocks consisting chiefly of quartzite and slates. This group has been called the *stratified group* and is rarely associated with felsite. Its area in Melrose and Saugus is therefore of particular importance in determining the relations between the stratified group and the felsites.

The quartzite and slates extend southwest from Melrose across Spot Pond. This southwestern extension of the stratified group across the region erroneously marked diorite by Mr. Crosby, separates the diorite from the felsite in that locality. The quartzite near the southwest corner of Spot Pond somewhat resembles felsite, and probably it is this fact that led Mr. Crosby to connect it with the felsite west of Pine Hill in Medford. The two rocks, quartzite and felsite, are entirely distinct and separated in that locality by a broad belt of granite. The area southwest of Crystal Lake in Melrose about the corner of Maine and Upham streets is occupied by the stratified group instead of felsite as marked by Mr. Crosby. In general the stratified group occupies the lowlands and the felsites form the hills.

A fine exposure of the quartzite and slates occurs near the Melrose railroad station. The stratification is distinctly marked in a ledge north of Poplar street and along Vintage street. The strike of the formation at this place is N. 75° W. and dip 30° towards the north. The same rocks occur near the junction of Washington and Ravine streets on the Melrose-Stoneham line, and are here within several hundred feet of the nearest exposure of felsite south of Washington street. This is an important locality, from the fact that the quartzite and slate are here exposed nearer to the felsites than at any other place along the southern boundary of the stratified group.

The rocks of the stratified group are said to vary greatly, but in the Melrose-Saugus area they are quite uniform throughout. The quartzite generally predominates. Its color is white or gray and it is clearly interstratified with the slates whose lines of sedimentation are distinct.

Some of the rocks of the stratified group have been incorrectly named felsite. There is no true felsite belonging to the stratified group. The quartzite and slates are wholly distinct from the felsites, both in structure and origin.

GRANITE.

The term granite is here used to include all granitic rocks associated with the felsites. These rocks differ considerably in their external appearance and will afford a rich field for study.

Mr. Crosby has represented the granite of West Medford as separated from that south of Spot-Pond by a broad belt of felsite. The felsite, as we have already stated, does not occur in the place represented by Mr. Crosby, and in its stead there is granite. Northeast of Prospect Hill, in Malden, there is quite a large area of granite which is not represented on Mr. Crosby's map. Another area occurs a mile further east along the Boston and Newburyport turnpike.

The boundaries of most of these areas are very easily traced and some very distinct junctions with the felsites and stratified group have been observed. In by far the greater number of cases, however, the line of contact is covered. Whenever there are good clean exposures along the boundary of the granite, careful searching will result in the discovery of a plane on the one side of which the rock is granite and on the other side of which the rock is of a different kind.

Near the west end of Long Pond in Melrose the granite contains distinct inclusions of the stratified group. The stratification in the enveloped fragments is very evident. In many places, along the boundary between the granite and the stratified group, the latter contains distinct intrusions of the former. These dike-like masses of granite frequently envelop large angular fragments of the stratified group. The distinct line of contact between the two kinds of rocks is proof that the granite and stratified group are different formations and do not pass into each other by a gradual transition. The stratified group is undoubtedly of aqueous origin and the facts enumerated above, as Mr. Crosby and others have already shown, are conclusive evidence that the granite is eruptive.

It must follow also that the granite in its present position is younger than the stratified group.[1]

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[1] Mr. M. E. Wadsworth informs me that the granite is distinctly eruptive at Swampscott, and that the rocks of that region are not correctly mapped by Mr. Crosby.

FELSITE

We have thus far used the term felsite in a general sense to include all those rocks which in this region have been called compact feldspar, petrosilex, porphyry, felsite porphyry, felsite, banded felsite, non-porphyritic felsite, hornstone, etc.

Mr. Wadsworth has shown that the felsitic rocks of this region may be divided into two groups. One group, owing to its high percentage of silica and general vitreous characters is related to the rhyolites, the other group having a lower percentage of silica and more basic characters, is related to the andesites or trachytes. The felsitic rocks of this region have not been studied thoroughly enough to admit of any but a provisional classification.

For the purpose of facilitating description I will call those related to the rhyolites, simply, *felsites*, and the other group related to the andesites and trachytes, I will include under the name *basic felsites.*

The felsites are a fine-grained mixture of quartz and feldspar. The mixture is very intimate and the feldspar largely predominates. Orthoclase and plagioclase are both present. The former is most abundant, but plagioclase sometimes constitutes a considerable portion of the rock. Most of the felsite has macroscopic particles of quartz, although they are usually not nearly so prominent as the porphyritic crystals of feldspar. The felsites vary greatly in external appearance, but are uniformly compact and massive, showing no trace of stratification or the fragmental structure which characterize clastic rocks. The microscope frequently reveals a well marked fluidal structure in the groundmass of the felsites. This structure, so common among the true felsites of this region, has not been, and in all probability never will be, observed in any rock belonging to the stratified group.

The felsites are probably more abundant than the "basic felsites." They occupy the greater portion of Marblehead Neck, and are found also in Lynn, Saugus, Melrose, Malden and Medford.

Great care has been taken while determining the boundaries of the felsites to discover their relations to the granite and stratified group.

Along the east side of Marblehead Neck the junction of the felsite and granite can be distinctly seen, and the felsite here contains inclusions of granite around which it has flowed. Directly opposite this locality, on the west side of Marblehead Neck, the junction of the felsite and granite can be seen in many places. Numerous dikes of felsite occur in the granite at this place, and some of them show distinct banding like that seen in the so-called banded felsites.

About a third of a mile north of Broadway station a well marked dike of felsite occurs in granite. The dike is five feet wide, with very distinct walls, and can readily be traced up the cliff more than twenty feet and across the country for a quarter of a mile. On Baker's Hill, Malden, a large dike of non-porphyritic gray felsite occurs. The width of the dike is about one hundred feet and its strike N. 30° W.

At the east end of Long Pond, in Saugus, there are several distinct dikes of felsite in the same granite, which at the west end of the pond, as already stated, contains well marked inclusions of the stratified group. North of Pine Hill in Medford there are numerous dikes of felsite in granite. One of the dikes is thirty feet wide, slightly porphyritic and has very distinct walls.[1] In fact all along the junction of the felsite and granite there are frequent thrusts of the felsite into the granite and inclusions of granite in the felsite. The junction is very irregular and sometimes difficult to trace, but where the rocks are clean I have not failed to find the line of an exposed contact. I have never seen an example of the passage of felsite into granite. The failure to find the junction in any case has been due to the absence of good exposures.

The numerous points of contact observed around almost all the granite areas, as well as the distinct dikes of felsite in the granite, show that the two rocks are distinct formations and do not pass into each other by an insensible transition.

The felsites which occur in dikes are in their present position undoubtedly eruptive. These clearly eruptive felsites occur, as I have already stated, at frequent intervals throughout the whole area occupied by the felsites north of Boston. They are exactly like and inseparably connected with the felsites of all the large areas and prove that all the felsites of that region are eruptive.[2] There are other important facts, to be noticed hereafter, that point to the same conclusion.

It must also follow that the felsites in their present position are younger than the granite.[3]

[1] According to Mr. M. E. Wadsworth there are numerous dikes of felsite in the granite along the Swampscott coast.

[2] Mr. Crosby admits that "exotic petrosilex and felsite undoubtedly exist" in this region, but he does not believe that *all* the felsites north of Boston are eruptive.

[3] Mr. M. E. Wadsworth in his paper "On the Classification of Rocks" has already drawn the same conclusion concerning the granite and felsite of Marblehead Neck.—Bulletin of the Museum of Comparative Zoology, Cambridge, Mass. Vol. v., No. 13, page 282.

There are a few observers in this country, and some of them are eminent scientists, who contrary to the general belief of lithologists, are of the opinion that the felsites of this region are of sedimentary origin. To support their hypothesis they depend chiefly upon the following arguments. They say:—

(1) That there is some "felsite which is clearly interstratified with quarzite, hornblende slate, etc.," and properly belongs to the stratified group. To distinguish the felsite of the stratified group from that which is not clearly stratified Mr. Crosby calls it stratified felsite.

(2) That the (unstratified) felsite passes into the stratified felsite and "the transition is so gradual that it is impossible to define the boundary between" them;

(3) That the "banding" in some of the so-called banded felsites "represents the original bedding of the rock";

(4) That on Marblehead Neck and at other places "conglomerate and sandstone pass into compact felsite."

With reference to the first argument I have already stated (*ante* p. 357) that there is no true felsite belonging to the stratified group. A microscopic examination shows that the rocks of that group are wholly distinct from the felsites both in structure and origin. The marked difference between the rocks of the stratified group and the felsites I shall point out in detail at some future time.

The second argument has been most frequently stated and the "statement" has been accepted generally as proving that the felsites were originally stratified rocks. The felsites and the stratified group are associated in Melrose and Saugus. According to Mr. Crosby this is not the only area in which such assocation occurs. It is, however, the one to which reference is usually made in speaking of the gradual transition from felsite to undoubtedly stratified rocks. Much time has been spent tracing the boundary between these two groups of rocks in order to determine their true relations.

Near the corner of Washington and Ravine streets in Melrose, where the felsite and stratified group are exposed within several hundred feet of each other, the two rocks are distinctly different and show no signs of gradual passage from one into the other. The distance between the two exposures is about eight hundred and fifty feet, and some persons may claim that beds of transition may possibly occur, and not be exposed. There is nothing in the two exposures that suggests the presence of beds of transition between them, and judging from what may be seen in other localities, I am led to believe that such beds do not occur. The line of contact between the felsites and the southern side of the stratified group is covered throughout its whole extent, and I have not been able to find the two rocks along the line, exposed nearer together than at the locality named.

North-east of Oakland Vale, along the northern border of the stratified group, a white quartzite, and dark slightly porphyritic felsite with distinct fluidal lines, occur within ten feet of each other. The line of contact is covered, but as in the other case, there is no sign of transition. We hope to find an exposed junction of the two rocks, and thus by direct evidence prove their relation.

Mr. Crosby in his report upon the "Centennial Map" page 17, speaking of the porphyritic felsite of Malden, Melrose, Saugus, and Lynn says: — "going northward in Melrose the porphyritic character gradually disappears, the felsite becomes more silicious and gradually becomes interstratified with quartzite and hornblende slates. The transition is so gradual that it is impossible to define the boundary between the stratified and unstratified felsites, which proves there is no break, no natural division here."

After reading the above statement, I carefully examined the rocks referred to, and must beg leave to differ with Mr. Crosby in every particular named. The most completely porphyritic felsite I have seen anywhere occurs near the south-west corner of Long Pond in Melrose, close to the stratified group where it is cut by the granite. The porphyritic character varies in the Malden Highlands, but there is no gradual decrease northward, as this suite of specimens plainly shows. The basic felsite along Washington street is just as porphyritic as that along Highland avenue or Salem street; but when we pass several hundred feet northward from the foot of the Highlands to the stratified group, we find rocks fundamentally different from those of which the Highlands are composed — rocks without the slightest porphyritic structure, and instead of the fluidal line of the felsite, they contain distinct lines of sedimentation.

Conclusive evidence as to the relation of the stratified group and felsite is found also in the relations which the two hold to the granite. It has already been shown that the stratified group is older than the granite, and that the felsites are younger than the granite.

The felsites and the stratified group are undoubtedly distinct formations in nature, notwithstanding the numerous statements of eminent authorities to the contrary.

The third argument we have noticed in favor of the sedimentary origin of the felsites, is drawn from the banding so prominent in some of the silicious felsites. There are two theories propounded to explain the origin of the banding. Those who believe that the felsites are sedimentary rocks, say that the banding represents the original bedding of the rock. Those who believe that the felsites of this region are truly eruptive rocks, say that the banding was produced by the flowing of the molten rock material at the time of its eruption. That these lines are of igneous origin is proved by a number of facts.

The banding is the same as that seen in rhyolites, whose igneous origin is undoubted. The similarity found by comparing the banded felsites with the banded glassy slag of a furnace, strongly inclines a person to refer the structure of both to the same general cause, although the particular conditions under which they were formed may differ widely.

On the west side of Marblehead Neck there are a number of dikes of banded felsite in granite. The banding is distinctly marked, and exactly like much of the banding seen elsewhere. In some of the dikes the banding is most prominent along their sides, following the irregularities of their walls; but in other dikes the banding extends throughout the dike, and is always parallel to its walls.

Half a mile north-west of the northern end of the pond near Saugus, is a high hill on which the junction of the felsite and granite can be seen. The felsite is finely banded, and the bands are parallel to the line of contact between the two rocks.

On the east side of Marblehead Neck a large piece of granite is enveloped by felsite the bands of which are parallel to the sides of the enveloped fragment. The bands in the dikes of felsite, along lines of contact with granite, and encircling enclosed masses of rock, must have been produced by motion when the felsitic matter was in a fluid state.

In order to compare the banding in felsites with lines of sedimentation, several thin sections were made of Cambridge slate at right angles to the plane of stratification. The sedimentary character of the slates is very evident under the microscope, and differs very markedly from the fluidal structure of the felsites. The groundmass of the latter flowed around and enveloped the porphyritic crystals which it contains. This peculiarity is sometimes visible without the aid of a microscope. The best example we have seen is in the reddish felsite at its junction with the black felsite on the east side of Marblehead Neck. The whole groundmass of the felsites must once have been in a viscous state, and flowed around the porphyritically enclosed crystals, pebbles, or anything it happened to pick up in its course. The lenticular forms thus produced about pebbles, have led some observers to conclude that a part of the banding in the felsites has resulted from a peculiar change in the pebbles of the conglomerate from which the felsite is supposed by them to have been derived.

The banding in the felsites is undoubtedly igneous, and instead of being an argument in favor of their sedimentary origin, proves their eruptive character. I shall notice, when considering the breccia, the argument drawn from the passage of conglomerate and sandstone into compact felsite to prove the sedimentary origin of the felsites.

The felsites of this region are not all of the same age. This fact has already been noticed by Mr. M. E. Wadsworth, who discovered a distinct junction between two felsites on the east side of Marblehead Neck.[1] Following the shore about two hundred yards north of the junction observed by Mr. Wadsworth, another line of contact may be seen between the same two felsites. The one felsite is reddish and coarsely porphyritic, the other is black and sparingly porphyritic. The junction last mentioned is more distinct than the first, and enables us to determine the relative age of the two rocks. In both felsites fluidal lines were produced in the flowing mass at the time of its eruption. In the reddish felsite these lines are parallel to the line of contact between the two rocks, and in the other they are not, proving that the reddish felsite is the one that flowed along the line of contact, and must be the younger of the two. Other junctions have been noticed in different places, but they have not yet been explored.

The "basic felsites" form the mass of the Malden Highlands and extend northward into Melrose. They may occur at other places, but I have not yet found time to trace their boundaries. The relation of the "basic felsites" to the felsites has not been fully determined. Their relation to the breccia will be considered later.

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[1] See paper referred to in note 3, *ante* p. 359.

BRECCIA.

The breccia is made up of angular and sub-angular pebbles, almost all of which are felsite. Those of granite and quartzite occur very rarely and in particular localities. Even in the Malden Highlands where the breccia is surrounded by "basic felsite" there are few if any pebbles of that felsite in the breccia. The fragments are commonly black, red or purple, and some are distinctly banded. They may be porphyritic or not, but almost all are very hard and flinty, differing markedly from the adjacent "basic felsite." The groundmass of the rock, or rather the paste in which the pebbles are embedded is usually light colored, non-porphyritic and quite compact. Sometimes the paste contains no pebbles and is very compact, closely resembling a light gray felsite.

There is no other rock in this vicinity whose boundaries are so difficult to determine as those of the breccia. The reason for this difficulty will be found in the genetic relations of the felsites and breccia.

North of Maplewood the breccia passes into a distinct sandstone and conglomerate. At the base of a hill a short distance northeast of Oak Grove Station, the breccia is associated with a red sandstone. Microscopic sections of these rocks have been made and show that they are distinctly sedimentary.

The passage of the breccia into distinctly sedimentary rocks has been noticed at other places by a number of observers, and is sufficient evidence to prove that the breccia is of aqueous origin, *i. e.*, that it was formed as ordinary sandstones and conglomerates were formed, but its fragments were not so completely rounded.

Near the corner of Pleasant street and Highland avenue, Malden, is a gravel pit in which the sedimentary formation of breccia is nicely illustrated. At some time during the past, when the waves beat against the hillsides (ten to twenty feet above present high tide level) at that place, angular pieces of felsite were torn off and shingled against the steep rocky shore. The mass of fragments differ from breccia only in this, that the latter has been consolidated.

It is evident that the felsites, fragments of which are found in the breccia, must be older than the breccia itself. We cannot, however, conclude from this, that all the banded and other silicious felsites are older than the breccia. On Marblehead Neck the breccia contains dikes of felsite, which must be younger than the breccia. The same is true of Cliftondale where the dikes of felsite are more distinctly marked than on Marblehead Neck.

The breccia of the Malden Highlands is composed almost wholly of fragments of silicious felsites. The "basic felsite" completely surrounds the brecciated area furthest north along the Malden-Medford line, and yet there are very few or no pebbles of "basic felsite" in this breccia. The facts indicate that the breccia was formed before the "basic felsite" occupied its present position.

The base of Prospect Hill, Malden, is breccia, and its top is "basic felsite." The same is true of the hill a short distance northeast of Oak Grove station; and in a number of other places the "basic felsite" seems to overlie the breccia. This evidence is in harmony with that already noticed, and makes it probable that the breccia is older than the "basic felsite."

It has already been stated that the line of contact between the felsites and the breccia is sometimes quite difficult to determine, but the reason for this difficulty will be readily comprehended when we understand the genetic relations of the two rocks. The breccia occurs at intervals throughout the whole area occupied by the felsites. Just before the more recent eruptions of felsite, the brecciated materials were scattered over the surface, and the fragments may have been loose, or only partially cemented together. The felsitic lava, at the time of its eruption, flowing over the surface, picked up many loose fragments and became very intimately and irregularly mixed with the materials of the breccia.

There was thus produced along the line of contact between the felsite and the breccia, a felsite containing many fragments cemented together by a paste of igneous origin. The number of fragments decreases with the increase of distance from the line of contact, and the felsite containing the included fragments, may be said to pass, on the one side, by a gradual transition into compact felsite. There is however, no such passage in the opposite direction, *i. e.*, between the felsite with included fragments and breccia. There is always a line of contact between these rocks in nature, but it is sometimes quite difficult to discover. As might be expected, an observer in the field may be in doubt whether a certain rock is breccia or felsite, and it may cost him much labor to find the lines of contact and settle the question. In this case the microscope becomes a very valuable help, for by using it to study a thin section of the rock the observer can readily tell whether the rock is eruptive or sedimentary. When the line of contact between the felsite and breccia is not prominently marked in nature, one of the best ways to find it is to make a series of microscopic sections on a line at right-angles to the line of contact. A study of the thin sections will enable the observer to tell between which two of the series the line of contact will be found. Having thus limited the area of observation the line can be found quite readily. A considerable portion of what is generally considered breccia is simply felsite containing fragments picked up at the time of its eruption.

The fourth argument in favor of the sedimentary origin of the felsites, like some of the other arguments, is not based on facts, and is therefore of no value.

CONCLUSIONS.

The stratified group does not contain, as a part of itself, a clearly interstratified rock which is properly called felsite.

The stratified group of Melrose and Saugus is cut by the granites of the same region, and must be older than the granites. The distinct line of contact between the granites and the stratified group proves that they are distinct formations. Facts already stated are undoubted evidence that the granites are eruptive.

The distinct line of contact between the felsites and the granites, together with the dikes of the former in the latter, are conclusive evidence that the two formations are distinct in nature, also that the felsites are eruptive, and that their extrusion has occurred since that of the granite.

That the felsites do not, by an insensible transition, pass into and become a part of the stratified group is shown by the markedly different characters of the two classes of rocks, as well as the distinctness of the boundary between them, and their different relations to the granite.

Chemical analysis, microscopical and petrographical relations, indicate that there are two kinds of felsitic rocks in this region. These have been provisionally called felsite and " basic felsite."

The banding in the felsites is a fluidal structure, and not the result of sedimentation. This is shown by the fact that the banding occurs in dikes of felsite, and is parallel to their walls. The microscopic structure of the felsites is proof of the same conclusion.

The relations of the felsites to the breccia, and also the distinct junctions between two varieties of felsites, show that they are not all of the same age. The eruption of some of the felsites occurred before the formation of the breccia, and after the breccia was formed another eruption occurred.

The passage of the breccia into sandstone and conglomerate indicates the sedimentary origin of the breccia.

The eruption of the "basic felsite" probably occurred after the formation of the breccia.

Supplementary Note.

Since the above paper was read I have examined a number of new thin sections of brecciated rocks in Malden and Saugus, and discovered some facts which have a very important bearing upon the origin of the felsites.

Prof. Zirkel in his report upon the rocks of the Fortieth Parallel, has described, under Younger Clastic Rocks,[1] some which contain to a greater or less extent splinters and chip-like sharp-edged fragments of volcanic glass.

Some of the rhyolitic tufas of California contain a great number of these peculiar conchoidal fragments, which, according to Mr. M. E. Wadsworth,[2] are identical with the splinters, chips and shards of glass described by Zirkel. The forms of the glass fragments differ very markedly from those of the other fragmental material, and at once become a very characteristic feature of clastic rocks containing fragments of volcanic glass.

About a mile north-east of Oakland Vale, on the north side of the stratified group, is an area of brecciated rocks. One of the thin sections from these rocks shows a large number of the peculiar volcanic-glass forms, and is incontrovertible evidence of the former presence of volcanic glass, which must have been brought to the surface by volcanic action.

Mr. Wadsworth has examined the thin section and accepts the facts as conclusive evidence of the former presence of fragments of volcanic glass. The fragments, as we would expect,[1] are no longer volcanic glass, but quartz, which is the product of alteration. The brecciated rock is an old rhyolitic tufa, perodite,[1] and it is remarkable that these peculiar forms have been preserved, when we consider the alteration to which the rock has been subjected. These facts are valuable not only as evidence in favor of the truly eruptive character of the felsites, but also as showing the similarity between ancient and modern volcanic products.

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[1] Geological Explorations of the Fortieth Parallel. Vol. IV., Microscopical Petrography, pages 265–271.

[2] Mr. Wadsworth examined the thin sections described by Zirkel in his report upon the rocks of the Fortieth Parallel. See Mr. Wadsworth's paper "On the Classification of Rocks." Bulletin of the Museum of Comparative Zoology, Cambridge, Mass. Vol. V., No. 13.

DISTORTED PEBBLES IN CONGLOMERATE.

BY W. O. CROSBY.

Under the above heading I wish to present, first, some observations that may stand as a rejoinder to the remarks of Mr. Wadsworth, made at a recent meeting of the Society, during the discussion which followed the reading of my paper " On the Evidence of Compression in the Rocks of the Boston Basin ;"[2] and, second, to describe the altered conglomerate in the town of Bellingham in this State.

The paper referred to, as will be remembered by many present, was devoted mainly to a description of the pebbles in a ledge of puddingstone, in the Brighton district of Boston.

Although Mr. Wadsworth seemed to argue against the deformation of pebbles in general, still it was chiefly to the conclusions drawn from the phenomena presented at this ledge, that he took exceptions, and consequently my reply is properly restricted to the same limited locality.

One point upon which, as it seems to me, considerable stress may fairly be laid, and which Mr. Wadsworth did not offer to explain, is the fact that the most of the indented surfaces of the pebbles, supposing them to be the effects of pressure, require pressure in a uniform direction ; *i. e.*, perpendicular to the stratification, and in precisely the same direction that pressure is required by the cleavage in the slaty layers of the puddingstone, by the fractured pebbles, which abound in this ledge, and by the cavities which appear between the fragments, and at the ends of many of the pebbles. I judge that no one will deny that the cleavage, fractures, and cavities must be the result of heavy pressure ; and yet, not to deny this, is equivalent to admitting that the rock has been powerfully compressed in the right direction to produce the most at least of the indentations, or, perhaps, all, if we make allowance for the necessarily irregular action of the pressure in a conglomerate.

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[1] See paper referred to in note 3, *ante* p. 359.

[2] Proc. Bost. Soc. Nat. Hist., xx, 308.

In other words, the pressure has been exerted, and exerted in the right direction to produce the effect. That this is a mere coincidence is possible; but before we adopt that conclusion, and reject a force proved to exist and at once so simple and so efficient, it seems only reasonable to make sure that the counter-explanation is at least equally satisfactory. But we can go further than this; the argument for the compression theory has not been fully stated. We are not only able to prove without reference to the indentations that the pebbles have been powerfully compressed in the right direction to produce these marks, but we are also in no wise dependent upon the indentations for evidence that some at least of the pebbles have been truly plastic; for a certain degree of plasticity must be admitted in those cases, and these are by no means rare, in which fractures have produced fissures of sensible width (one to six mm.) on one side of the pebbles and yet failed to break them in two, the fractures ending before reaching the other side. I have frequently observed these gaping and yet incomplete fractures on surfaces recently exposed by quarrying, or by my own efforts with the hammer, where it was impossible that they should have been widened by the action of the elements. Here, then, we have evidence entirely independent of the indentations, and apparently of an irrefragable character, proving that the pebbles have been compressed in the right direction to produce the indentations, and that they have been plastic. In my estimation, the only important point not readily explained by the compression theory, is the elongation of many of the indentations; and even this is partially, perhaps entirely, accounted for by the squeezing-out tendency, — the extension of the material of the rock in the plane of bedding,— of which the cleavage, fractures, and polar cavities afford abundant evidence.

Although the indentations, as they appear on the surface of the ledge, are found mainly upon the upper northern aspect of the pebbles, yet I must insist that the east-west trend of the most of those which are sensibly elongated is an insuperable objection to the glacial theory of their origin. And still less competent is this theory to explain those impressions which are found, as I certainly have found them, on nearly vertical, or even overhanging walls of rock facing the south. The ledge is divided in an east-west direction by a rather abrupt natural depression, something over five feet in depth; and indented pebbles have been observed on both walls of this.

Another agency invoked by Mr. Wadsworth, viz.: grains of sand impelled by wind and rain, is unquestionably competent to abrade very hard materials; and I am not disposed to deny that some of the effects observed at this locality may be fairly ascribed to its action. But here two puzzling questions arise: (1) Why, according to this theory, are the exposed pebbles worn away, as a rule, only on the north side? And (2) why are similar effects not observed in other localities where the same quartzite conglomerate is exposed under seemingly identical conditions?

All these considerations, however, are subordinate to the principal objection raised by Mr. Wadsworth, which is that the indented or distorted pebbles exist only on the present surface of the ledge; that excavation does not develop new ones; and that they are to be found only on those portions of the present surface which have been exposed for a long time to the action of the elements. In answer to this, I have to say, that during a recent visit to the locality, in company with Mr. George H. Barton, my attention was directed mainly to a search for indented pebbles below the present surface of the ledge, and with such success that, although, as I have already shown, the paste adheres very firmly to the pebbles, so that weathering is usually required to develope their true forms, and it is, hence, natural to expect that the comparatively slight indentations attributable to compression, will be conspicuous only on the weathered surface of the rock, I am able to assert with even greater positiveness than before that indented pebbles do exist below the present surface.

The elongated impressions or grooves, more or less perfectly developed, were occasionally observed, although they seem to be less characteristic of the unweathered than of the weathered surfaces of the puddingstone; but most of the impressions were of more normal form. The best example of this kind was discovered by Mr. Barton. The specimen includes three approximately equal quartzite pebbles. One of these, at the points where it touches the other two, shows two well-marked indentations which fit very neatly over, and have undoubtedly been produced by, the convex surfaces of the adjacent pebbles ; while the material between the indentations has been squeezed up to an acute angle.

It is, no doubt, often easy to explain the concave surfaces and accurate fitting of the pebbles as merely accidental, as incidents of the sedimentary process; but in this particular example I think the indications of compression are plain enough to require at least the provisional acceptance of the theory that the pebbles have been plastic, especially since the pressure and plasticity have been proved by entirely independent evidence.

But after all, what large element of improbability is there in this matter of the deformation of quartzite pebbles? Quartzite is a variety of sandstone, and sandstone is consolidated sand; and there is no question but that among these rocks we have all degrees of consolidation from incoherent sand to the firmest quartzite. A very slight degree of pressure will distort a ball of sand, or even of some rocks called sandstone ; and where, in passing to more throughly consolidated varieties, are we to stop and say, "beyond this point no compression is possible?" And in this connection it is important to remember that the pressure exerted during some geological operations is very great.

Mr. Wadsworth has asserted that the distortion of the pebbles would be attended by the development in them of a fluidal structure. I do not know that he has proved by microscopical examination that the fluidal structure does not exist in the indented pebbles of this ledge ; but it seems to me that the statement that distorted pebbles necessarily possess this structure, involves an assumption which we have no right to make ; viz. : that the plasticity of the pebble means the plasticity of the constituent particles thereof. The plasticity of a ball of sand does not reside in the single grains, but is due to their imperfect cohesion ; and even in the firmest quartzite, it is fair to assume that the solid grains are stronger than the cement which unites them. Consequently, the cement is the first to yield, but when it has yielded, the unequal pressure is thereby removed from the grains, and distortion may be accomplished without the aid of sensible plasticity in the latter.

It will be said, however, that we must not regard the distortion as a purely mechanical process. Very true; but the argument is not affected when chemical agents are admitted. These things we know: the cement of the quartzite is mainly silicious; and water, possibly alkaline, must have been present, and under the influence of great pressure and a more or less elevated temperature. Of the solvent power of water under these conditions, few will need to be informed, and it is easy to guess what part of the rock would be most affected by it; viz., the cement, for this is not only more easily reached by the water, but it is silica which has been deposited from aqueous solution, and is probably not yet entirely anhydrous, and consequently retains in a measure its capacity for dissolving in water. Whether the forces invoked are mechanical or chemical, or both, I think it is easy to see how the integrity of the cement may be destroyed, and the forms of the pebbles altered, while the solid grains of vitreous quartz remain essentially intact. Supposing that this happens, what chance is there for the development of fluidal structure? Take a ball of sand; so far as any definite arrangement of the particles is concerned, it may be said to be structureless. Impress it with the thumb and produce a slight distortion of its form. What has happened internally? a general displacement of the particles in that part of the ball, no doubt, but has any definite arrangement been established? I think the microscope would fail to show it. We have simply disturbed the structure of a structureless mass! And yet I fail to see that the conditions are necessarily essentially different, when we pass from this ball of sand to a pebble of quartzite. Plasticity of the constituent particles, probably results in many, but not necessarily in all, cases of distortion. This part of the subject may be closed with the remark that the well-known facts with regard to the contortion without rupture of rigid rocks like quartzite and limestone, and the distortion of fossils in cleaved slates, etc., seem alone sufficient to place the distortion of pebbles in the catalogue of phenomena which are inherently probable.

The conglomerate of the Boston basin is, with scarcely any doubt, of Primordial age, representing the same general horizon as the Braintree and Cambridge slates, although mainly underlying these. The evidence that some of the hardest pebbles in this conglomerate have been distorted by pressure is rather scanty, as the preceding discussion shows, and yet it seems to me fairly satisfactory. But I now invite the attention of the Society to a much older conglomerate in portions of which nearly all the pebbles have suffered an extreme degree of deformation, the evidence in this case being, apparently, all that could be desired, both as to quantity and quality.

The conglomerate here referred to, occurs in the south-west part of the town of Bellingham in this State, and in the adjacent part of Rhode Island. A very meagre description of the rock itself may be found in Hitchcock's Final Report on the Geology of Massachusetts, under the head of "metamorphic slate;" while in this eminent observer's well-known paper[1] upon the altered conglomerates occurring at various points in New England, the existence of distorted pebbles in the Bellingham conglomerate is merely mentioned; but, so far as I am aware, no adequate description of the phenomena which this rock presents has ever been published. This is all the more singular, since the evidence of the compression and distortion of pebbles is certainly much clearer here than in some of the localities which President Hitchcock has described in considerable detail. Bellingham, however, is a region of extensive drift deposits, good natural exposures of the rocks, and especially of the conglomerate, being almost entirely wanting; and the only artificial excavation within my knowledge in which the distorted pebbles are well displayed is one which President Hitchcock probably never saw. This is a cut on the New York and New England Railroad (main line), a short distance east of Mill River and near the eastern boundary of Blackstone.

In my "Contributions to the Geology of Eastern Massachusetts," now publishing by this Society,[2] I have given a general sketch of the stratigraphical relations of the Bellingham conglomerate. Like the altered conglomerate described by President Hitchcock, in the paper already cited, at several points in Vermont, and elsewhere, by Mr. Vose,[3] at Rangeley Lake, in Maine, and by Mr. Burbank[4] in Harvard, Mass., the Bellingham conglomerate is intimately connected with, and is essentially a part of the great gneiss and mica schist formation of New England.

The rocks of this region dip to the east and north-east; and in Uxbridge and the west part of Blackstone, there are schistose gneisses which become more micaceous and more quartzose eastward, giving way to mica schist and quartzite in the eastern half of Blackstone. The mica schist seems to pass gradually upward into the so-called "metamorphic slate," which begins near the western boundary of Bellingham as a well-marked hydromica schist, alternating repeatedly with beds of sandstone and conglomerate, which are also more or less micaceous, the sandstone and smaller grained conglomerate being on this account often with difficulty recognized as such. Farther east the formation appears to undergo a gradual change toward argillite, becoming at once less micaceous and less conglomerate ; and the highest beds observed, in the western edge of Franklin, are a very good argillite, though still slightly micaceous.

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[1] Amer. Jour. Sci. (2), xxxi, 372.

[2] Occasional Papers, Bost. Soc. Nat. Hist., iii, 146-147.

[3] Memoirs Boston Soc. Nat. Hist., i, 482.

[4] Proc. Bost. Soc. Nat. Hist., xviii, 224.

The relations of the conglomerate to the arenaceous and micaceous strata are usually very intimate, the conglomerate, sandstone and schist being interstratified in thin beds, and the conglomerate often changing to finer material along the strike, as is so often seen in the fragmental rocks of later ages; so that Hitchcock has well described this formation as "a distinct mica slate, and a no less distinct conglomerate;" while in his general paper, already cited, on altered conglomerates, figure 3, illustrating the relations of the conglomerate and talcose (hydromica) schist in Wallingford, Vt., would answer equally well as a representation of the relations of these rocks in Bellingham. Distorted pebbles are not to be observed in all parts of the Bellingham conglomerate, but, on the contrary, the aspect of the rock, at least as far as the pebbles are concerned, is frequently that of a normal pudding-stone. The pebbles are mostly small, rarely exceeding three inches in diameter.

As already stated, the best exposure of the conglomerate with deformed pebbles is on the New York and New England Railroad, near Mill River. The dip at this point, is E. N. E. 20°–30°; and there is much hydromica schist and micaceous sandstone interstratified with the conglomerate.

The deformation of the pebbles in the conglomerate beds is an undeniable fact; and I judge that no one who has seen the rock *in situ* will hesitate to admit it. As a rule, in the altered conglomerates of New England the pebbles are flattened, the tendency being to form thin lenticular layers, which interlace and give rise to a distinctly schistose structure. In Bellingham, however, it is quite evident that the metamorphism has been mainly a drawing out or stretching, rather than a flattening process; it is as if the pebbles had experienced an endwise pull, instead of compression by a force exerted in one direction only. The typical form of the distorted pebble is not a lenticular layer, but a spindle-shaped rod, which is sometimes nearly cylindrical or prismatic, and usually presents transverse sections of similar shape in all parts of its length.

As already intimated, the distortion does not stop at the incipient stage, as in the Boston conglomerate, but a large proportion of the pebbles have taken on forms which are absolutely inconceivable, as the result of any known mode of attrition. Pebbles six to ten inches long, and less than one inch in diameter are not at all uncommon; and I have measured those which were more than a foot long, and less than one and a half inches in diameter; while there are comparatively few in which the ratio of the length to the diameter falls below 4 : 1. Elongation, however, is not the only evidence of distortion. As a rule the ends of the pebbles are not rounded, but they more often taper gradually to a sharp thin point, and I have observed cases where the surfaces toward the extremities were actually concave, like the edge of a razor, giving a termination of exceptional sharpness, and one that could not possibly be developed by surf action. In other cases the edges or extremities of the pebbles become blended with the cement, or with the substance of adjacent pebbles, so that their outlines are lost.

The pebbles are all elongated in the same direction, and this is invariably parallel with the strike of the beds. The structure is such that any vertical surface cutting across the strike affords the aspect of a normal conglomerate, the pebbles exhibiting no sensible deformation; while on any surface parallel with the strike, whether in the plane of the beds or cutting them at any angle, there is nothing to suggest the real nature of the rock; for, viewed in this manner, it shows no trace of pebbles, but only a beautiful schistosity, resulting, apparently, from the interlacing of thin lenticular layers of various colors and diverse composition; although, as just stated, on the cross-section these seeming layers are seen to be rods.

This curious structure clearly admits of but one explanation, viz.: the horizontal pressure which folded the strata, and operated in a direction at right angles to the strike, has been accompanied by a sensibly equal vertically acting force or pressure, and under the combined influence of these, the beds and likewise their constituent pebbles, have been squeezed out in the direction of least resistance, or parallel with the strike.

Occasionally one may see a pebble of epidote or other refractory material which has successfully resisted the drawing or squeezing out process, and is now enveloped by the lithologic strings resulting from the deformation of the more yielding adjacent pebbles, which are wrapped about it so as to conform closely with its surface. The pebbles appear to have been originally all well rounded and they consist largely of quartzite, though granite, diorite, petrosilex (?), and chloritic, slaty and epidotic rocks and epidote, are represented in their composition. I have seen no pebbles which seem to have been derived from a micaceous rock. That the pebbles are *real* pebbles, and not concretions of any sort, is shown by the forms of those that retain their original outlines, by their varied composition, and by their textures. Every pebble is enveloped in a layer of micaceous material, and the original paste is to a large extent replaced by this mineral, which it seems necessary to regard wholly as a product of the alteration which the rock has undergone.

Briefly stated, the transformation of the conglomerate, where complete, appears to be as follows : the pebbles, as such, disappear, leaving a schistose or foliated structure; the greater part of the paste, and probably a portion of the pebbles, are converted into a distinct mica or hydromica; and, finally, the quartzose and feldspathic materials contained in the original pebbles become more distinctly and coarsely crystalline. Thus the puddingstone is changed to something which is not easily distinguishable from a coarsely schistose, micaceous gneiss, such as is found in the neighboring towns of Mendon, Blackstone, and Uxbridge. And it is highly interesting to observe that these same gneisses possess some of the most striking structural peculiarities of the altered conglomerate. For instance, I have repeatedly observed in the gneiss that a transverse vertical section shows no schistosity, no stratification, only a coarsely granitoid aspect ; while on a strike section the schistose structure stands out prominently, which shows that in the gneiss, as in the conglomerate, the quartz, feldspar, etc., are not in layers, but strings. On account of possessing this semi-fibrous structure, the dip of the gneiss is not always easy to determine. Simultaneously with the alteration of the conglomerate to a gneiss-like rock, the arenaceous and argillaceous beds are changed, with less difficulty, to quartzite and mica schist; though it is likely that much of the true argillite must always remain essentially unaltered, being, for chemical reasons, insusceptible of metamorphism.

As already remarked, conglomerates exhibiting extensive alteration are known to occur at many points throughout New England;

and the number of these localities will probably be increased by more extended and careful observation. These conglomerates are probably of several different ages; and yet the metamorphic process appears to have been substantially the same in every case. As a rule, the altered conglomerate is closely associated, geognostically, with gneiss or mica schist; and in every such instance the product approximates to one or the other, or both of these rocks. Nearly all observers agree that these remarkable passages of sandstone and conglomerate toward mica schist and gneiss, are due to alteration and not to derivation; there seems little room for doubt on this point. And yet, as previously stated, the gneiss-like products of the alteration of the conglomerate are frequently difficult to distinguish from the schistose gneisses forming a large part of this great gneissic formation. Such identity in the effects seems to imply similarity in the causes, some community of origin; and I am somewhat inclined to regard the small area of semi-crystalline rocks in Bellingham as essentially a part of the gneiss and mica schist formation, and to see in the more conglomerate portions an indication of the condition of a large part of our schistose gneisses at some time in the remote past, — a small sample arrested in its development, and now available as a key to the origin of thousands of square miles of crystalline rocks.

I am aware, however, that altered conglomerates have not been studied sufficiently to justify positive statements with regard to their bearing on the problem of the genesis of crystalline schists; and all that I wish to do in this connection is to suggest that, unless the alteration of conglomerates is granted, it becomes a very difficult question to account for the almost complete absence of this class of rocks from the stratified crystalline formations. For we know that the stratified crystallines have, in the aggregate, an enormous volume; and this, as well as many other characteristics, shows that they must be regarded, in large part, as shore deposits. We know, further, that the seas, even in the earliest times of which geology furnishes any material record, were sufficiently near their present *status*, both physically and chemically, to permit the existence of life — probably both animal and vegetable. Now it is simply impossible to believe that an ocean which permitted the formation of vast beds of limestone, graphite, and iron ores, and the existence of life, did not deposit extensive formations of conglomerate; the sediments of early times must have included nearly, if not quite, as large a proportion of fragmental material, as those of later times. With very rare exceptions, these primitive conglomerates cannot now be found. And the question is, if they have not been converted into crystalline schists, what has become of them? At the same time, the present condition of such remnants as are left points very strongly to this solution of the problem, and indicates that the first step in the destruction of the conglomerate, as such, has been the distortion of the pebbles.

By these considerations, I am led to the conclusion that the distortion of pebbles, instead of being an exceptional, is probably a very general, phenomenon ; and it seems to me likely that, since the formation of conglomerates first began, more pebbles have suffered distortion than have escaped that process.

SOME CHARACTERS USEFUL IN THE STUDY OF THE SPHECIDAE.

BY W. H. PATTON.

PELOPOEUS Latr. (1804).

American type: *P. caementarius* (Drury) Smith.

Black, with markings usually of a yellow color. Clypeus bilobed at the apex, rarely entire (more narrowly produced, and the lobes not so distinct in the male). Mandibles of the female broad, armed with a distinct tooth near the apex. Sutures of the meta-episterna distinct. Claws of all the tarsi armed with a short tooth near the middle; two bristles on base of pulvillus, and four above them. Petiole of the abdomen as long as the entire thorax. Cocoons without any layer of white silk, the black plug at the end uncovered.

CHALYBION Dahlb. (1843).

Type: *Chalybion caeruleum.* (*Sphex caerulea* Linn. Syst. Nat., I, 941 ; *Chalybion cyaneum* Dahlb.)

Blue or violet. Clypeus tridentate at the apex, and in the female sometimes with a small additional tooth at each side. Mandibles of the female slender, of even width throughout, and unarmed (*Ch. caeruleum*); or, short, broad and blunt, and armed with a blunt tooth near the apex (*Ch. Zimmermanni*). Sutures of the meta-episterna indistinct beneath the fovea. Claws of the posterior tarsi unarmed; two bristles on the base of the pulvillus, and six above them. Petiole of the abdomen not so long as the metathorax. Cocoons with a loose exterior layer of white silk, which covers also the black plug at the posterior end of the cocoon. In this genus, as well as in

Pelopoeus, the mandibles of the males are unarmed, slender and acute.

This genus affords an interesting example of the value of color as a generic character. Separated from *Pelopoeus* by Dahlbom in 1843 (*Hymenoptera Europaea*), it was rejected by him two years later in the supplement of the same work, and no characters aside from color were discovered to distinguish it. No subsequent author has discovered additional characters, or has ventured to reëstablish the genus. The characters which I have given above, however, prove that the distinct coloration was a sufficient generic indication.

As Dahlbom indicated no type, I select the common American species. In *Ch. caeruleum* ♀ there are two small teeth on the clypeus in addition to the three central ones, the margin of the third ventral segment is sinuate, and there are tomentose spots on the third and fourth ventral segments (Dahlbom stated that these spots were on the second and third segments). *P. californicus* Sauss., said to differ from *caeruleum* in the slightly shorter petiole, I do not consider distinct. I have before me ♂ and ♀ specimens from California which agree in all respects with *Ch. caeruleum.*

Ch. Zimmermanni Dahlb. ♀ differs from *Ch. caeruleum* in the following characters: clypeus tridentate, no side teeth; third ventral segment not sinuate, and the third and fourth without any black sericeous spot; punctures of head and thorax distinct, not confluent, no median elevated line on clypeus or front; no median sulcation on disk of metathorax; face narrower beneath, mandibles broad and blunt, and with a broad and blunt tooth near the apex; mandibles shorter than in either *Ch. caeruleum* or *Pelopoeus.*

To *Chalybion* belong also *Ch. texanum* (*P. texanus* Cress.), and *Ch. aztecum* (*P. aztecus* Sauss.).

CHLORION Latr.

Edge of the clypeus with three teeth in the male, and five teeth in the female. Mandibles armed with a stout tooth in both sexes. Sutures of the meta-episterna distinct. Claws of all the tarsi armed with one tooth. Spines of anterior tarsi of ♀ no longer than the fourth tarsal joint. Labrum short and transverse as in *Chalybion* and *Pelopoeus.*

After carefully studying the arguments given by Westwood, Trans. Ent. Soc. Lond., iii, 227–230 (1840), it remains evident that as Latreille confounded two very distinct genera in his genus *Chlorion*, and as his views as to the type of the genus were originally confused, the next subsequent author had the right to decide to which section the name should be restricted. It was therefore, proper for Jurine to select *lobata* as the type of *Chlorion* (which he considered to constitute only a section of *Sphex*), and to apply a new generic name, *Ampulex*, to *compressa.* This application of the names *Chlorion* and *Ampulex* is also in conformity with general usage. The ♂ of *Ampulex* has the mandibles armed with a tooth, the mandibles of the female are unarmed.

ISODONTIA[1] n. g.

Type: *Isodontia philadelphica.* (*Sphex philadelphica* Lepel.; *Sphex apicalis* Smith, Cat. Hym. B. M., IV, 262.)

Clypeus of the ♀ with a notch in the middle of the elevated anterior border, and a short tooth on each side of the notch; clypeus of the male simple or with a slight crenulation. Margin of the labrum finely pubescent; labrum of female with a median carina, and armed with two spines or teeth at the apex. Mandibles short, terminated in both sexes by three teeth of equal, or nearly equal length. Marginal cell not extending beyond third submarginal, third submarginal receiving the second recurrent nervure near its base; the second submarginal usually longer than in *Sphex.* Anterior tarsi armed with short spines, not pectinate externally in either sex, the exterior spines being no longer than those within. Tarsal claws bidentate beneath, the outer tooth as large as the inner or larger. Only two bristles between the claws. Petiole of the abdomen more than twice the length of the posterior coxæ, the abdomen narrowed towards the petiole, depressed.

Isodontia philadelphica.

Labrum of female with a slightly incurved spine at the apex on each side of the median carina which is present, the labrum slightly roughened, its border slightly sinuated between the spines; labrum of male rounded anteriorly, without carina and not roughened. Mandibles of female black; of male, varied with ferruginous. Clypeus of female with a broad and slight notch.

Isodontia elegans. *Sphex elegans* Smith., Cat. Hym. B. M., IV, 262, ♂.

Labrum of the female with two short teeth at the apex, from each of which an oblique ridge extends backwards, the median carina distinct, the labrum very slightly roughened, its border slightly sinuated between the teeth; labrum of the male with a more or less distinct median carina, and very slightly roughened, the apex very slightly notched in the middle, but without teeth. Clypeus of female with the notch deep and narrow.

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[1] ἶσος + ὀδους.

The males of this species often vary in having the tibiæ and last tarsal joint black. The females closely resemble the males.

Isodontia tibialis. *Sphex tibialis* Lepel., Hym., III, 339.

Labrum of female with a sharp median carina, a straight cariniform tooth on each side of it at the apex, and a slightly curved transverse carina just behind them, the border excavated between the teeth. Labrum of male roughened and with a distinct median carina, and a short carina on each side of it at the tip; anterior border rounded. The clypeus of the female with the median notch narrow, and deeper than in *philadelphica*.

Saussure states (Novara Hymenoptera, p. 39), that the petiole of the female of this species, differing from the male, is short as usual in *Sphex*. I judge from this that he has confounded the female of *Sphex flavipes* with the female of *I. tibialis*.

Dahlbom's *Sphex pennsylvanica* is certainly not the Linnean species at present recognized under that name, but appears to be a synonym of *Isodontia tibialis*. Yet, such is the confusion of localities in Dahlbom's work, specimens from the most remote quarters of the globe being referred to the same species, that little confidence can be placed in a synonymical reference when, as in this case, a species is said to occur in Pennsylvania and New Holland. As Dahlbom had only one specimen of his species it is probable that his description relates to some New Holland species which resembles *Isodontia tibialis*.

To *Isodontia* belong also the following species: *I. nigella* (*Sphex nigella* Smith) from China, *I. azteca* (*Sphex azteca* Sauss.) from Mexico, and *I. costipennis* (*Sphex costipennis* Spin.) from South America.

I. azteca differs from the other species, with the possible exception of *costipennis*, in the labrum being entirely smooth and unarmed, and in the mandibles being bidentate in both sexes. But the mandibles are short and the teeth apical as in *Isodontia*, and the anterior tooth in the ♀ is broadly truncate, and evidently corresponds to two of the teeth of *I. philadelphica*. The notch in the clypeus of the ♀ is broad and slight. The petiole is of equal length in the two sexes, and in its other characters this species agrees generically with *I. philadelphica.*

SPHEX Linn.

(*S. ichneumonia, S. pennsylvanica* and *S. flavipes.*)

Clypeus of the female crenate on the margin, or with short, broad teeth; clypeus of the male truncate, the margin crenulate. Labrum of the female with a median carina, the margin finely pubescent, not armed with teeth. Mandibles of the female curved and ending in a long pointed tooth; armed with a large subtriangular tooth within, and this tooth armed at its proximal base with a minute sharp tooth. Mandibles of the male with only one tooth on the inner margin. Marginal cell extending beyond the third submarginal. Claws of the tarsi armed with two teeth at the base beneath, the outer tooth the smaller; only two bristles between the claws. Anterior tarsi of ♀ ciliated externally with long bristles. Petiole of the abdomen no longer than the posterior coxae; abdomen convex, the tip pointed in the female.

Gastrosphaeria Costa, differing from *Sphex* in its "conico-globoso" abdomen and "truncato-concave" tip of antennae, appears to contain our species; but the characters given are not sufficient to establish a distinct genus.

Sphex ichneumonea Linn.

Clypeus of the female with two slight, divergent lobes in the middle of the anterior margin, and a very slight angle just externally to them; clypeus of the male slightly crenulated on the anterior margin. Labrum ferruginous; labrum of the female obtusangular anteriorly and the median carina forming a point at the apex, the median and basal portions of the labrum polished, the lateral and anterior margins marked off by a faint line, and a subtriangular median area marked off by a similar line; in the male this inner area much more distinct, the apex of the labrum obtusangular and rounded, there being no median carina. In the male the apical ventral segments are concave, the fifth, sixth and seventh pubescent, with the pubescence at the sides long; the seventh ventral segment sharply emarginate.

Sphex flavipes Smith.

Clypeus probably as in *ichneumonea.* Labrum of the female as in *ichneumonea,* but, being black or piceous, the delimitations of areas are, as in *pennsylvanica,* not apparent; in the male the labrum, as in the female, angular anteriorly, the apical half having a median carina which forms a point at the apex, this carina less distinct than in the female, no distinct median area. In the male the apical ventral segments are concave, the fifth, sixth and seventh pubescent, with the pubesence at the sides long; the seventh ventral segment distinctly sinuated.

My ♀ specimen of *flavipes*, from Eastern Tennessee (E. M. Aaron), differs from Smith's description as follows: Length, 21 mm. (not 13 lines); disk of clypeus glabrous, face clothed with a dense brownish pile, and sprinkled with long hairs of the same color; apical margin of labrum not exactly "rounded"; the pubesence of thorax not "golden" but brownish, and on the metathorax white; the tegulae ferruginous (a character not mentioned by Smith); the abdomen not entirely opaque; the apical joint of tarsi and the claws shaded with fuscous. But all these differences excepting the size, the ferruginous tegulae and dark tarsal tips, and possibly the rounded labrum, may be due to this specimen being worn and faded. The color of the tegulae and tips of the tarsi may easily have been overlooked, or may vary.

Two males, received with the female, differ from Smith's description of the female (the male not previously described), as follows: Length, 20 mm; all the pubescence white; tegulae tinged with piceous; apical joint of the tarsi and the claws blackish; wings subhyaline; in one specimen the face golden.

Sphex pennsylvanica Linn.

Clypeus of the female with two obtuse crenations in the middle of the anterior margin, representing the slight lobes of *ichneumonea*; clypeus of the male obtusely crenate on the anterior margin. Labrum of the female slightly rounded anteriorly, the carina not forming a point at the apex, median and basal portion roughened; labrum of the male with the edge nearly straight, the basal and middle portions polished, not roughened, but with no distinct indication of areas. In the male the apical ventral segments are convex; the eighth segment and the sides of the seventh with a dense velvety pubescence; the seventh ventral segment entire, or very slightly sinuate.

Harpactopus Smith.

American type: *H. rufiventris* (Cress.) Patton.

Clypeus in both sexes with a broad sinus on each side, the central portion broadly produced and truncate. Labrum of female semicircular, truncate at the apex, the truncation bounded by a pair of stout, slightly divergent, truncated processes, the labrum with a broad thickened margin separated by an impressed line; labrum of the male short, evenly rounded anteriorly and unarmed, the epipharynx extending beyond it as a broad membranous margin subangularly rounded at the apex. Labrum in both sexes ciliate with long bristles on each side and without any median carina. Mandibles of the female with two stout teeth on the inner side, the proximal tooth the larger. Mandibles of the male with only one tooth within. Marginal cell not extending beyond third submarginal. Tarsal claws bidentate, second tooth as large as the first or larger; a long curved bristle between the claws in addition to the two smaller and straight ones. Anterior tarsi of the female ciliated externally with long bristles. Petiole a little longer than the posterior coxae; abdomen convex, the tip pointed in the female.

This American group differs in some respects from the Old World group of which the type, *H. crudelis* Sm., is said to have the clypeus notched in the middle of the margin. The characters given above must, therefore, be understood to apply to the American species only. Until the typical form is more carefully described we cannot safely propose a new genus for our species.

PRIONONYX Dahlb.

Type: *P. Thomae* (Fabr.) Dahlb.

Clypeus of the female produced in its whole width; a deep notch in the middle, above which is an elongated depression. Clypeus of the male not so broadly produced, slightly sinuated anteriorly. Labrum of the female narrowed anteriorly and bilobed, the lobes ciliated with long bristles, and separated by a large square sinus; in the median line a short prominent carina which extends as a short tooth into the sinus. Labrum of male narrowed anteriorly, the narrowed portion ciliated with long bristles, the anterior border broadly sinuate, the sinus not ciliated. Mandibles of the female with two teeth on the inner side, the proximal tooth the smaller, yet larger than the corresponding tooth in *Sphex*. Marginal cell not extending beyond the third submarginal. Tarsal claws with five teeth beneath, the outer teeth the largest, the basal tooth very small, but distinct; a long curved bristle between the claws in addition to the two smaller and straight ones. Anterior tarsi of the female ciliated externally with long bristles. Petiole no longer than the posterior coxae; abdomen convex, the tip pointed in the female.

Both Dahlbom and Smith have described the tarsal claws of *Priononyx* as quadridentate, doubtless overlooking the small basal tooth which is difficult to see unless the claw is detached. This fifth tooth is present in both *thomae* and *atrata*.

In the ♀ of *thomae* the notch in the clypeus is shallow, and above it is a rounded depression. Small specimens of *atrata* approach *thomae* in these respects. In the ♂ of *thomae* the 6th and 7th ventral segments have a deep median sinus on the margin. In *atrata* the margin of these segments is entire.

LIST OF THE NORTH AMERICAN LARRADAE.

BY W. H. PATTON.

SYNOPSIS OF THE GENERA.

I. Eyes reniform; second submarginal cell petiolate . . PISON

II. Eyes entire; second submarginal cell not petiolate.
  A. Exterior margin of the mandibles scarcely emarginate.
    a. First submarginal cell shorter than the two following taken together, divided by a spurious nervure. Eyes of the ♂ meeting on the vertex. Two spurs on the intermediate tibiae. ASTATA
    b. First submarginal cell longer than the two followin. together, not divided. Eyes not meeting on the vertex. Mandibles not dentate within. LIRIS
  B. Exterior margin of the mandibles with a broad and deep emargination near the base.
    a. Three distinct ocelli. . . . . LYRODA
    b. Posterior ocelli distorted or obsolete.
      1. Metathorax as long as the mesothorax, truncated behind; marginal cell truncate. LARRA
      2. Metathorax shorter than the mesothorax, rounded behind; marginal cell narrow and rounded at the apex. Mandibles dentate within. . . . . . TACHYTES

PISON Spin. (1808).

Syn. *Tachybulus* Latr. (1809); *Nephridia* Brullé (1833).

Type of Spinola: *P. ater* (Spin.).

Pison laevis Sm., Cat. Hym. Brit. Mus., IV, 317, ♀.

Pison conformis Sm., Trans. Ent. Soc. Lond., 1869, 297.

ASTATA Latr. (1796).

Syn. *Dimorpha* Jur. (1807).

Type: *A. boops* (Schrank).

Astata unicolor Say, Narr. Long's Ex., II, 337, ♀; Smith, Cat. H. B. M., IV, pl. 8, f. 1, ♂.

Astata rufiventris Cress., Tr. Am. Ent. Soc., IV, 218, ♀.

Astata bicolor Say, West. Quart. Rep., II, 78, ♂ ♀. *Astata terminata* Cress., Tr. Am. Ent. Soc., IV, 218, ♂.

Astata nubecula Cress., Proc. E. S. P., IV, 466, ♂.

Astata insularis Cress., Proc. E. S. P., IV, 140, ♀.

LIRIS Fabr. (1804), Dahlb. (1843).

Type of Fabricius: *aurata*. No American species known.

LYRODA Say (1837).

Type: *L. subita* Say.

Mandibles with a deep and broad excavation beneath and in the ♀ with two teeth within, the proximal tooth broad, its apex retuse, separated from the other tooth by a sharp notch; in the ♂ no trace of teeth within. Clypeus of the ♀ with three distinct teeth on each side, the labrum slightly sinuate; clypeus of the ♂ narrowly and slightly produced, concealing the labrum, the apex of the clypeus bisinuate. Eyes parallel, the inner margin slightly sinuate. The three ocelli distinct and round. Prothorax raised, forming a distinct node, obtusely three-angled. Metathorax elongate, truncate. Marginal cell of anterior wings truncate, distinctly appendiculate; first submarginal longer than the two following together; second submarginal narrow and narrowed one-half, or in the ♂ more than one-half, towards the marginal, unequally six-sided, the transverse nervures nearly straight; third submarginal slightly produced at the apex, not lunate, the submarginal vein extending distinctly beyond; the first recurrent nervure received near the base, the second beyond the middle of the second submarginal cell, far apart; submedial cell of anterior wing extending as far as the medial cell on the externo-medial nervure. Enclosure on the sixth dorsal segment of the abdomen in the ♀ broad, pilose.

The genus *Morphota* Smith (1856) appears to be synonymous with this, Smith's description applying well in all but the form of the prothorax which is said to be "transverse"; and this difference is probably one of words rather than of structure.

Lyroda subita Say, Bost. Journ., I, 372, ♀. *Tachytes subitus* Sm., Cat. H. B. M., IV, 307; *Larrada subita* Cress., Tr. Am. Ent. Soc., IV, 213.

Lyroda triloba Say, Bost. Journ., I, 372. *Tachytes trilobus* Sm. Cat. H. B. M., IV, 307; *Larrada triloba* Cress., Tr. Am. Ent. Soc., IV, 213.

yroda caliptera Say, Bost. Journ., I, 373.

LARRA Latr. (1802), Fabr. (1804, nec 1793).

Syn. *Larrada* Smith (1856).

Type of Latr., Dahlb., and Smith: *anathema.*

The type is said to have no teeth on the inner margin of the mandibles, and it was upon this character that Panzer, Illiger, and Dahlbom based the distinction between this genus and *Tachytes.* In all the American species examined by me the teeth are more or less distinct, sometimes as distinct as in *Tachytes*, and in all cases, even in the males, apparent. This character appears to be liable to the objections which may be raised against all characters derived from the presence or absence of an organ. I have, therefore, employed the characters given by Smith, as they appear also to separate the genera more naturally. But this arrangement has its difficulties, and it may yet be necessary either to subdivide both genera or to throw them into one.

The genus *Scolia* was established by Fabricius in 1775, and no indication of the type was given by him either at that time or subsequently. In the Entomologia Systematica (1793) he described a genus *Larra* and, contrary to his custom in that work, gave a full description drawn from *4-pustulatus.* There is nothing in the writings of the early authors to show that they placed first in the genus the species which they regarded as typical, nor indeed, that they had any idea of "types." Smith's statement, in 1856, that *vespiformis* was the type of the Fabrician *Larra* (because, perhaps, it stood first in Fabricius' list) is, therefore, not to be left unchallenged. A genus, in the conception of Fabricius, contained species which agreed in essential structure. The species, therefore, from which he described that structure, if he indicates it, must be taken as typical of the genus no matter where it stands in the list. The *4-pustulatus* stands next to the last. The *ichneumoniformis* stands third in the list. In the Syst. Piez. (1804) Fabricius decided that *4-pustulatus* belonged to *Scolia*; *vespiformis* and *ichneumoniformis* he still retained in *Larra*. The *Larra* of 1793 becomes, therefore, a synonym of *Scolia* and a new genus *Larra* is made for the non-typical species. But Latreille in 1802, Hist. Nat., vol. III, had described a genus *Larra* with *ichneumoniformis* as its type. The name, therefore, should be quoted from Latreille, and as *vespiformis* is now known to be generically distinct from *ichneumoniformis*, *vespiformis* cannot be its type. In 1802 also Latreille established a genus *Stizus* with *tridentata* (of which *Larra bifasciata* Fabr. is a synonym) as its type; to this species *vespiformis* is allied. Fabricius 1804, therefore, should be quoted as authority for *Larra* in synonymy only, since his genus contained the types of *two* of Latreille's prior genera.

Even if this reasoning were not convincing we should be obliged to accept Latreille's decision as to which portion of the Fabrician genus should retain the name — and he selected *ichneumoniformis* as typical. *L. ichneumoniformis* Fabr. is a recognized synonym of *L. anathema* (Rossi).

Larra argentata Beauv., Ins. Afric. et Amér., 119, t. 3, f. 9. *Lyrops argentata* Say, Bost. Journ., I, 370; *Larrada argentata* Smith, Cat. H. B. M. IV, 292.

Larra distincta. *Larrada distincta* Smith, Cat. H. B. M., IV, 292, ♀.

Larra acuta n. sp.

Larra arcuata. *Larrada arcuata* Smith, Cat. H. B. M., IV, 293, ♀.

Larra luctuosa. *Larrada luctuosa* Smith, Cat. H. B. M., IV, 289, ♀.

Larra luteipennis. *Larrada luteipennis* Cress., Tr. Am. Ent. Soc., II, 293, ♂.

Larra ignipennis. *Larrada ignipennis* Smith, Cat. H. B. M., IV, 288, ♀ ♂; Cress., Proc. E. S. P., IV, 137.

Larra trifasciata. *Larrada trifasciata* Smith, Cat. H. B. M., IV, 290, ♀.

Larra vinulenta. *Larrada vinulenta* Cress., Proc. E. S. P., IV, 138.

Larra pensylvanica Beauv., Ins. Afric. et Amér. 118, t. 3, f. 8. *Larrada pensylvanica* Smith, Cat. H. B. M., IV, 292.

Larra fuliginosa Dahlb., Hym. Eur., I, 138 and 472, ♀ ♂. *Larrada fuliginosa* Smith, Cat. H. B. M., IV, 288. ?*Larrada Dahlbomi* Cress., Proc. E. S. P., IV, 138.

Larra aethiops Say, Bost. Journ., I, 372.

Larra aethiops. *Larrada aethiops* Cress., Proc. E. S. P., IV, 465, "♀"; *Larra aethiops* Patton, Bull. U. S. Geol. Surv., V, 354 ♂.

Larra americana. *Larrada americana* Cress., Tr. Am. Ent. Soc., IV, 214, ♂.

Larra canescens. *Larrada canescens* Smith, Cat. H. B. M., IV, 292, ♀.

Larra tenuicornis. *Larrada tenuicornis* Smith, Cat. H. B. M., IV, 293, ♀.

Larra laevifrons. *Larrada laevifrons* Smith, Cat. H. B. M., IV, 291.

Larra montana. *Larrada montana* Cress., Proc. E. S. P., IV, 465, ♀ ; *Larrada parvula* Cress., Proc. E. S. P., IV, 465, ♂.

Larra belfragei. *Larrada Belfragei* Cress., Tr. Am. Ent. Soc., IV, 215, ♀.

Larra terminata. *Larrada terminata* Smith, Cat. H. B. M., IV, 291, ♂.

Larra analis Fabr., Syst. Piez., 220, 8. *Larrada analis* Smith, Cat. H. B. M., IV, 291.

Larra divisa Patton, Bull. U. S. Geol. Surv., V, 368, ♀.

Larra tarsata Say, West. Quart. Rep., II, 78. *Larrada tarsata* Cress., Proc. E. S. P., IV, 464, ♀.

Larra semirufa. *Larrada semirufa* Cress., Proc. E. S. P., IV, 464, ♀ ; Pack., First Ann. Rep. U. S. Ent. Comm., 318, f. 55 and 56.

Larra texana. *Larrada texana* Cress., Tr. Am. Ent. Soc., IV, 214, ♀.

Larra bicolor Fabr., Syst. Piez., 221, 12. *Tachytes bicolor* Dahlb., Hym. Eu., I, 471, 15 ; *Tachytes bicolor* Smith, Cat. H. B. M., IV, 303 ; *Tachytes* (*Lyrops*) *pagana* Dahlb., Hym. Eu., I, 132, ♂ ♀. *Larrada pagana* Smith, Cat. H. B. M., IV, 286 ; *Larrada americana* Sauss., Novara Hym., 74.

Larra fulviventris. *Lyrops fulviventris* Guér., Icon. Règ. Anim., III, 440; La Sagra's Hist. Cuba, VII, 320, VIII, pl. 18, f. 9 (1857) ; and "Ins., 766, pl. 18, f. 9"; *Larrada fulviventris* Smith, Cat. H. B. M., IV, 286.

LARRA DISTINCTA (Smith).

Both sexes of this species vary in having two or three of the basal segments of the abdomen red; intermediate forms are rare, but both the red-marked and the black varieties are equally common and occur together.

L. distincta is peculiar for having the labrum slightly produced and deeply notched in the middle. The mandibles are distinctly bidentate in both sexes. The clypeus is broadly and abruptly, but slightly produced, and is transversely impressed near the apex; the margin armed with three teeth on each side in the ♀, the lateral teeth being the angles of the process and the inner teeth being the angles of the smooth border, in the male only two teeth are present on each side and the border is more rounded out. The front is prominent, the anterior ocellus in an isolated pit, the area behind it not prominent and not bilobed. The posterior ocelli are obliquely distorted and narrowly drawn out. The eighth ventral segment of the ♂ is broad and entire at the apex. The ciliation of the anterior tarsi of the ♀ is short, the bristles equalling the third tarsal joint in length.

LARRA ACUTA n. sp.

♀. Length 8–9 mm. Black; head, thorax, antennae and legs clothed with a very fine silvery pubescence, the pubescence more distinct on the face and longer on the metathorax; three basal segments of the abdomen when viewed from behind with a broad apical silvery band, in other lights these bands disappearing and the basal portion of the segments having a silvery reflection. Mandibles piceous in the middle, strongly bidentate within like the mandibles of *Tachytes*. Clypeus not dentate, broadly but slightly produced, the sides of the process angular; labrum distinct, entire, medially impressed; head and thorax finely and closely punctured, the anterior portion of the clypeus more coarsely punctured and bordered by a transverse impression. The front and the disk of clypeus swollen, a depression, angulated above, between the eyes and antennae on each side of the face; two slight elevations just above the antennae, between which is an impressed line extending to anterior ocellus and continued above over the prominence and through the depression on vertex; posterior ocelli obliquely distorted into an ellipse, but not drawn out into a linear appendage; eyes approaching on the vertex, their inner border sinuous. Mesonotum abrupt anteriorily, its anterior portion with a broad median impression on each side of which is an impressed line. Metathorax abruptly truncate, the sides and upper surface uniformly and finely granulated, the posterior face limited above by a transverse ridge beneath which is a deep elongated depression in the median line, on each side of this the posterior face delicately rugose transversely. Anterior tarsi strongly ciliate, the bristles exceeding the second joint of the tarsus in length. Wings subhyaline, tegulae and nervures black or piceous; marginal cell obliquely truncate as in *distincta* (Sm.), indistinctly appendiculate; recurrent nervures distant at their insertion into the second submarginal cell, more distant than in *distincta* and much more so than in *argentata* Beauv. Area on sixth segment of the abdomen narrow and pointed, glabrous, margined, its disk sometimes sparsely punctured.

Waterbury, Conn., Aug. 20th, 21st and 24th.

In size and color *acuta* bears much resemblance to the black males of *distincta*. It is related to *terminata, tarsata* and *montana*.

TACHYTES Panz. (1806).

Syn. *Lyrops* Illiger (1807).

Type of Panz. and Ill.: *species with dentate mandibles.*

Type of Westwood (1840): *pompiliformis* Pz.

The type *pompiliformis* has a distinct appendiculation to the marginal cell. Other species having no appendiculation to the marginal cell may require to be set apart, and as *etrusca*, the type of *Lyrops* Ill., is one of these, the name *Lyrops* might be adopted for the new genus. But as the name *Lyrops* of Illiger has properly passed into synonymy, the present date and not Illiger's should be quoted. Dahlbom in 1843, however, established a new group *Lyrops* with *pagana* as type (the *Lyrops* of Illiger being at that time obsolete) and proposed the name *Tachyptera* for the species without appendiculation, with *obsoleta* as type. It may be well, therefore, to let *Lyrops* share the fate of *pagana* and adopt *Tachyptera* with *obsoleta* as the type, notwithstanding that *obsoleta* is strictly congeneric with *etrusca*, the type of Illiger's *Lyrops*.

Some of the species here referred to *Tachytes* may need, therefore, to be called *Tachyptera* or *Lyrops*, and most of those referred to *Larra* may require the formation of a new genus (and for this new genus the name *Larrada*, n. g. nec. Smith, would be convenient); but I do not at present find sufficient characters for separating *Tachyptera* from *Tachytes* or such new genus from *Larra*. As a number of the species, both of *Tachytes* and *Larra*, given in this list are at present unknown to me I do not vouch for their validity, but in a subsequent paper hope to discuss both the generic and specific structural characters more fully.

Tachytes labiatus. *Sphex labiata* Fabr., Ent. Syst, II, 211, 52; *Pompilus labiatus* Fabr., Ent. Syst., Supp., 247, 9; Syst. Piez., 191, 16; *Tachytes labiatus* Smith, Cat. H. B. M., IV, 306; *Tachytes murina* Dahlb., Hym. Eur., I, 132, ♂ ♀.

Tachytes pepticus. *Lyrops peptica* Say, Bost. Journ., I, 371, ♂ ♀; *Tachytes pepticus* Smith, Cat. H. B. M., IV, 308.

Tachytes argentipes Smith, Cat. H. B. M., IV, 306, ♀.

Tachytes insularis Cress., Proc. E. S. P., IV, 140, ♂ ♀.

Tachytes obscurus Cress., Tr. Am. Ent. Soc., IV, 217, ♀.

Tachytes texanus Cress., Tr. Am. Ent. Soc., IV, 217, ♂; *Tachytes texanus* Patton, Bull. U. S. Geol. Surv., V, 368, ♂.

Tachytes repandus. *Liris repanda* Fabr., Syst. Piez., 231; *Tachytes 3-cincta* Dahlb., Hym. Eur., I, 125; *Tachytes repanda* Dahlb., Hym. Eur., I, 470 and xxiii; *Tachytes 3-cinctus* Smith, Cat. H. B. M., IV, 306.

Tachytes sericatus Cress., Tr. Am. Ent. Soc., IV, 216, ♂ ♀.

Tachytes fulvipes. *Larrada fulvipes* Smith, Cat. H. B. M., IV; 288.

Tachytes distinctus Smith, Cat. H. B. M., IV, 307, ♀. *Tachytes distinctus* Cress., Tr. Am. Ent. Soc., IV, 215; ?*Tachytes aurulenta* Lepel., Hym., III, 247.

Tachytes cubensis Cress., Proc. E. S. P., IV, 139, ♂ ♀.

Tachytes elongatus Cress., Tr. Am. Ent. Soc., IV, 215, ♂.

Tachytes validus Cress., Tr. Am. Ent. Soc., IV, 216, ♂ ♀; *Tachytes breviventris* Cress., Tr. Am. Ent. Soc., IV, 216, ♂.

Tachytes crassus n. sp.

Tachytes mandibularis n. sp.

Tachytes harpax n. sp.

Tachytes 3-cinctus. *Liris 3-cincta* Fabr., Syst. Piez., 229, 5.

Tachytes aurulentus. *Larra aurulenta* Fabr., Syst. Piez., 220, 7; *Lyrops aurulenta* Say, Bost. Journ., I, 371, 3; ?*Tachytes aurulenta* Lepel., Hym., III, 247; ?*Tachytes aurulentus* Smith, Cat. H. B. M., IV, 306 and 307.

Tachytes dives Lepel., Hym., III, 247, 8, ♀.

Tachytes abdominalis. *Larra abdominalis* Say, West Quart. Rep., II, 77, ♀; *Larrada abdominalis* Cress., Tr. Am. Ent. Soc., I, 379; *Tachytes abdominalis* Cress., Tr. Am. Ent. Soc., IV, 217.
Tachytes caelebs Patton, Bull. U. S. Geol. Surv., V, 355 ♂.
Tachytes rufofasciata Cress., Tr. Am. Ent. Soc., IV, 217, ♂.
Tachytes fulviventris Cress., Proc. E. S. P., IV, 466, ♀.

TACHYTES CRASSUS n. sp.

♀. Length 15–16 mm. Robust; black; head, scape, thorax, femora and basal segment of the abdomen clothed with golden pubescence, the pubescence on collar and postscutellum somewhat silvery and that on disk of mesothorax and on metathorax and base of abdomen somewhat griseous; the pubescence more brilliant on the face and, in certain lights, upon the usual parts of the thorax; the ventral segments clothed with an appressed brown pubescence; first, second and third dorsal segments with a narrow silvery margin, extending beneath upon the second and third segments; dorsal area of the sixth segment black, clothed with appressed piceons bristles, the sixth segment margined with shorter bristles. Middle of the mandibles, the labrum, the palpi, the knees, tibiae and tarsi, the tegulae and nervures, ferruginous; wings yellowish subhyaline, the apical margin paler. Body very finely punctured. Clypeus broadly and abruptly produced, the process glabrous, margined, the middle of the margin forming a broad rounded tooth or short lobe, the margin at each side having three crenulations or slight teeth. Labrum with a slight sinuation in the narrow anterior border, fringed with stout spinules. Tubercle of the ocelli clothed with silvery pubescence; the posterior ocelli much drawn out, extending downwards on the sides of the tubercle; behind the ocelli a transverse arcuate or triangular depression from which an impressed line extends upon the vertex. Anterior portion of the mesonotum depressed in the middle, the lateral impressed lines being placed on the elevations at each side. Scutellum with a slight median impression, extreme base of the metathorax with two or three transverse grooves; metathorax subtruncate, its upper face with a distinct median impressed line, this line widening or forking posteriorly to enclose a smooth spot upon the verge of the truncation; posterior face of the truncation medially impressed. Tarsi sparsely fringed with short spines, first joint of anterior tarsi with six spines exteriorly, the spines shorter than the third tarsal joint, the fourth joint of all the tarsi unarmed, the posterior tarsi with short spines at the tip of first and second joints internally but none at the tip of the third joint internally.

Waterbury, Conn., July 21st and August 5th, on the flowers of *Asclepias incarnata.* The specimens slightly worn. In unrubbed specimens it is probable that the armature of the tarsi and of the clypeus would be the same as in the following species. The females of the three species here described are closely related, the principal differences being found in the color of mandibles, scape, tibiae and dorsal area, in the number of silvery bands and in the impression on scutellum and groove on metathorax.

This appears to be the species which has been mistaken by Massachusetts Entomologists for the *aurulenta* of Fabricius, but Fabricius described the wings of his species as "obscura." From *aurulenta* Smith this species differs in having no "notch in the middle of the anterior margin of the clypeus." The *aurulenta* of Lepeletier appears to be different from that of Fabricius, but differs also from *distinctus* Smith.

TACHYTES MANDIBULARIS n. sp.

♀. Length 13 mm. Black, the head, scape beneath, thorax and femora clothed with golden pubescence, the pubescence more dense and brilliant in the usual positions, the pubescence long on the thorax beneath; basal segment of the abdomen with a thin silvery pubescence, apical margins of the four basal segments of the abdomen silvery; second ventral and the margins of the other ventral segments clothed with an appressed brown pubescence which in certain lights appears silvery; dorsal area black, coarsely punctured, the appressed bristles piceous; abdomen with the usual rows of erect bristles. Base and middle of the mandibles, the palpi and labrum, the scape beneath, the knees, tibiae and tarsi, the tegulae and nervures, ferruginous. The wings yellowish subhyaline, the apical margin clearer. Body very finely punctured. Clypeus broadly and abruptly produced, margined, all but the margin pubescent; the middle of the margin produced into a quadrate tooth, the tooth bituberculate or medially impressed, the margin on each side having three teeth, the outer tooth most distinct and somewhat oblique. Labrum with a slight median impression in the narrow anterior border, fringed with stout spinules. Posterior ocelli drawn out as usual upon the sides of the tubercle, the tubercle divided by a median impression which extends upon the vertex, and encircled by an impressed line which expands into a pit behind. The four impressed lines on the mesothorax anteriorly distinct, the lateral ones placed on elevations. Scutellum not distinctly impressed medially; extreme base of the metathorax with two or three transverse grooves, metathorax rounded, its upper face with a median groove, the groove delicately striate transversely in the middle, ending in a fovea posteriorly; posterior face of the metathorax medially impressed, the impression broader and deeper above. Spines of the anterior tarsi equalling the second joint of the tarsus in length, the first joint with six or seven spines externally, fourth joint of all the tarsi armed with slender spines, all the joints of the posterior tarsi armed both externally and internally, the spines within being longer than those without. New Haven, Ct., July 12th; Southington, Ct., July.

♂. Length 11 mm. The dorsal area silvery, defined posteriorly by the lateral truncations, the apex truncate. The eighth ventral segment broadly excavated at the apex so as to form two remote teeth. Joints 3–7 of the antennæ crenulated beneath. The anterior margin of the clypeus slightly rounded out, entire, only the tooth at the extreme side being distinct. Labrum not seen. The median impression on the upper face of metathorax distinct only at the base and apex. All the tarsi, excepting the basal joint of the anterior pair, without armature, the spines probably being worn off. New Haven, Ct., July 12th, on the flowers of sumach (*Rhus*).

Smaller male specimens, (which may be a seasonal-dimorph or belong to a distinct species) have the femora more broadly ferruginous. The median tooth and the three lateral teeth of the ♀ clypeus are present as rudiments, the labrum is like that of the ♀, the groove on metathorax is distinct, and the tarsi are armed with spines arranged like those of the ♀ but more slender. Waterbury, Conn., Aug. 16th and 27th, on flowers of golden-rod (*Solidago*).

The smaller size, the unimpressed scutellum and the presence of a fourth silvery band distinguishes the ♀ of this species from *T. crassus.*

TACHYTES HARPAX n. sp.

♀. Length 11–13 mm. Agrees with the description of *mandibularis,* in all but the following points. Dorsal area golden. The labrum, the middle and extreme apex of the mandibles, and the scape of the antennæ beneath dark piceous. All the tibiae with a black stripe beneath. The three lateral teeth of the clypeus equally distinct. Scutellum with a distinct median impression; the groove on upper face of metathorax represented by the fovea only. Waterbury, Ct., Aug. 18, 28, and 21.

♂. Length 12 mm. Resembles the ♀, but the spines of the tarsi are more slender, and an impressed line is apparent upon the disk of the metathorax. The antennæ are more strongly crenulated beneath than in *mandibularis* ♂. The middle of the anterior margin of the clypeus is thickened, and forms a broad angle beyond which extends the angulated labrum; on each side of the anterior margin of the clypeus are three distinct teeth. The sixth ventral and seventh dorsal segments are tufted with fuscous pubescence; the seventh dorsal is silvery, the area not so distinctly defined laterally as in *mandibularis*. The eighth ventral forms two broad lobes at the tip, separated by a deep and narrow notch. Waterbury, Ct., Aug. 5th.

I have observed the female of *Tachytes harpax* carrying her prey, a female specimen of *Xiphidium brevipenne* Scudd. Capturing both together in a cyanide bottle, when the wasp alit on a leaf to get a new hold on her burden, I removed them from the bottle in a few minutes, after the wasp was dead, and it is worthy of note that two days after its removal from the bottle the *Xiphidium* was sensitive to touch and capable of slightly moving its limbs. Can this have been due to a neutralization of the cyanide by the paralyzing effect of the wasp's sting, or was it owing to the *Xiphidium* having greater natural power to withstand the cyanide?

The European *T. obsoletus* was observed by Fabre (Ann. Sci. Nat., IV ser., Zool. VI, p. 147, 1856), to provision its nest with the larvæ of *Oedipoda*, and he observed *T. tarsina* capture a larval Acridian. The European *T. pompiliformis* was "frequently" captured by Shuckard with a "small sandy-coloured caterpillar." Dahlbom saw it capture and drag to its nest the larva of *Gryllus rufus*; Smith took it with the pupae of grasshoppers, and Lichtenstein (Bull. Soc. Ent. Fr., (5) iii, p. cxxii) observed it store its galleries with grasshoppers, (*Chortipus*). No observations had previously been made upon the American species.

In noting the nesting habits of a Brazilian species of *Larra*, Frederick Smith has stated incorrectly, (Proc. Ent. Soc. Lond., 1859, p. 55), that the tarsal claws of *Tachytes* are "bifid"; they are simple, as in the other genera of the family, but stouter and with a more decided curve. The species of *Tachytes* are very partial to the flowers of *Asclepias.* But the insect observed by Mr. V. T. Chambers, and a figure of the tarsus of which, with the attached pollinia of *Asclepias*, was published in the American Naturalist, vol. i, p. 105, and in the Guide to the Study of Insects, p. 165, was incorrectly referred to *Tachytes* by Dr. A. S. Packard, Jr. Indeed, that figure bears no resemblance to the tarsus of *Tachytes*, but represents tolerably well the tarsus of a *Sphex*, an insect of a different family.

So quick are these insects in their motions, and so watchful are they that their capture is difficult. However stealthily they are approached while resting on the flowers, their green eyes are sure to face the intruder, and the least suspicious act sends them circling in the air, or off in an exceedingly rapid flight.

NOTES ON THE PHILANTHINAE. BY W. H. PATTON.

Male Philanthinae are peculiar for having upon the apical margin of the lateral lobes of the clypeus, a fringe of hairs which may be known as the "moustache." In *Philanthus* the outer hairs of the fringe are long and silky, and are appressed to the clypeus, being directed towards the median line, or, so to speak, combed towards the parting. It may be that these hairs can be raised at the will of the insect. In *Aphilanthops*, *Eucerceris* and *Cerceris* this fringe is shorter and erect, and in many specimens of the last named genus, the hairs are so closely set that they form what appears to be a chitinous lobe slightly narrowed towards the end, and with its apical border emarginate. This appearance may be due to some operation performed by the insect, and it may be that these dandies "wax" their moustache. In none of the *Aphilanthops* or *Eucerceris* examined have I seen this waxed appearance. In some species the fringe is not so well developed as in others, but in all it is a prominent character, although in a few, as for instance the species of *Aphilanthops*, it is not very distinct because of the presence of other pubesence upon the face. When the moustache is moistened with honey it becomes darker in color. Although the moustache of *Philanthus* is figured by Savigny in Napoleon's *Egypt*, it does not appear to have been described by any author. The fringe on the clypeus of *Cerceris* has been noticed before, but by Saussure it has sometimes been described as a "lobe" of the clypeus.

In *Philanthus* the clypeus is broad, and in the middle extends upwards towards the middle of the face, producing a three-lobed form; the median portion is narrowed above, and squarely cut off from the piece which lies between the antennae. The side lobes which do not extend upwards, are bounded above by a transverse suture; and at the point at which the suture over each of the lateral lobes meets the side sutures of the extended median portion, there is present on each side a slight pit, to which the term *fovea* may be applied.

In *Philanthus* and *Aphilanthops* the side lobes of the clypeus do not touch the eyes; in some species of *Eucerceris* ♂ they almost touch the eyes, and in ♀ *Eucerceris* they do touch the eyes; in *Cerceris* ♂ and ♀ they always touch the eyes. There is here a gradual narrowing of the face and, accompanying it, we find a change in the form of the suture over the lateral lobes of the clypeus. In the females of the *fulvipes* and *canaliculatus* sections of the genus *Eucerceris*, the suture limiting the side lobes of the clypeus above is evenly arched, and there is a slight depression extending downwards from the fovea; in the females of the *zonatus* section the face is greatly widened below, and the sutures over the side lobes are nearly as in *Philanthus*; in *Eucerceris* males the suture over the side lobes is oblique, and from its inner end there extends downward for a short distance, between the side and middle lobes, a continuation of the suture. In both sexes of *Cerceris* the form of the sutures is similar to that in the males of *Eucerceris*. With the narrowing of the face the side lobes of the clypeus have pressed upwards, the limiting suture, at first straight, has become arched, and finally, its inner portion has been pressed against the sides of the median lobe, the *fovea* driven upwards, and a suture produced indicating the line in which the side lobe is pressed against the median lobe. In some species of *Cerceris* the process is carried still further; in *C. compar*, *C. mandibularis*, etc., the side lobes take an orbicular form, and in *C. venator* they become higher than broad. The suture extending downwards from the fovea in *Cerceris*, and *Eucerceris*, together with the sutures extending from the fovea to the base of the mandibles may be termed the foveal sutures. It is worthy of note that they never extend below a point corresponding to the position of the fovea in *Philanthus*.

It will be observed that this account of the clypeus is very different from that given by Dr. A. S. Packard, Jr., (Proc. Ent. Soc.

Phila., vi. p. 51, 52), who claims that the side lobes do not belong to the clypeus, but are "submandibular pieces," and belong to the epicranium, and who applies the term "foramina" to the foveae notwithstanding that there is no perforation. In arguing for the distinctness of the side lobes from the presence of the short suture between the lobes of the clypeus in *Cerceris*, Dr. Packard has entirely misunderstood the nature of these sutures, and overlooked the fact that the clypeus of *Philanthus* does not differ greatly from that of the *Larradae* and certain *Sphecidae*, and that *Cerceris* is the most specialized genus.

In regard to the *foveae*, it may be stated that they indicate points of attachment for the *endocranium* or inner skeleton of the head; and that their analogues exist in other families of the Hymenoptera, and also in other orders of insects. In *C. compar* ♀ this inner skeleton consists of two parallel rods attached at opposite sides of the occipital foramen, and extending to the suture over the side lobes of the clypeus. These rods are slightly flattened and twisted, and have their edges thickened. The anterior third of the rod is expanded into a curved plate, and the end of this plate is attached along the suture, from the mandible to the fovea.

The mandibles of *Cerceris*, as described, are tridentate. An examination of many of our species shows much variation. The mandibles in the males of the greater number of species (including *bicornuta*, *fumipennis*, *sexta*, *deserta*, etc., *fulvipes*, *clypeata*) are without teeth, just as is the case with the mandibles in both sexes of *Philanthus* and *Aphilanthops*, and in the males of *Eucerceris*. In *Eucerceris* ♀ the mandibles in the species examined have only one tooth on the inner side, and this tooth varies both in position and size according to the species. Most species of *Cerceris* have two or three small teeth near the middle or base of the mandibles in the female, and the arrangement and form of these teeth afford specific characters. *C. compar* Cress. and *C. mandibularis* Patton are peculiar for having a distinct tooth on the middle of the inner border of the mandibles in the *male*, and for having the mandibles of the female much expanded within, near the middle, and bearing upon this expansion the minute teeth found in other species of *Cerceris*. It appears, therefore, that the tooth on the mandible of the male of those species is a vestige of this expansion. The male of *C. insolita* Cress. resembles *C. mandibularis* in having a small tooth on the mandibles. In *C. compacta* ♀ there is a large and sharp recurved tooth near the base, another large tooth beyond the middle, and a small tooth between them. In the male of *compacta* the tooth near the base is as in the female, but the others are absent.

In *Cerceris* and *Eucerceris* the lateral apical borders of the posterior coxae above (particularly the inner border), are produced into large rostrate carinae between which the narrowed base of the trochanters plays, the posterior trochanters are angulated within, and the apex of the posterior femora is dilated to form an irregular flange with a flattened posterior face. In *Philanthus* and *Aphilanthops* the apophyses of the coxae are small and slender, and the femora are not dilated at the apex.

In all the Philanthinae the insertion of the recurrent nervures is at or before the middle of the cells by which they are received, and *Eucerceris* does not differ from *Cerceris* in this respect, although the first recurrent is more commonly inserted nearer the base of the second submarginal cell than in *Cerceris*. Yet I have a specimen of *C. deserta* Say in which the first recurrent nervure of one wing unites with the first transverse cubital nervure, and many species show great individual variation in the insertion of the recurrents.

The characters which I find to separate *Cerceris* and *Eucerceris* are: the form of the marginal and submarginal cells; the sexual differences in the venation of *Eucerceris*; the presence of a space between the eyes and side lobes of the clypeus in *Eucerceris* ♂ which is absent in *Cerceris*; the absence of lateral sinuations on the anterior border of the labrum in *Eucerceris* ♀ which are present in *Cerceris*; the mandibles of the female, which in *Eucerceris* have one tooth on the inner margin, and in *Cerceris* have two or three; the presence of transverse median depressions on the abdominal segments in *Eucerceris* which are absent in *Cerceris*; the teeth terminating the carinae which bound the area on the dorsal valve of *Eucerceris* ♂ which are absent in *Cerceris*; and the narrowed eighth ventral segment of *Eucerceris* ♂ extending beyond the dorsal valve, while in *Cerceris* the ventral valve is broad and not produced beyond the dorsal valve.

But in *Eucerceris cingulatus* Cress. ♂ the transverse depressions on the abdominal segment are very indistinct, and in *Cerceris bicornuta* Guer. ♂ the eighth ventral segment resembles that of *Eucerceris*. In many species of *Cerceris* also, the male mandibles are unarmed; and in *C. fumipennis* Say the labrum of the female is as in *Eucerceris*.

The area on the dorsal valve of the males has deep scattered punctures in both *Cerceris* and *Eucerceris;* but in the females the punctures are shallow and confluent. *Eucerceris* used as a generic name is a misnomer. The name could properly apply only to the typical section of *Cerceris*, which this genus is not.

APHILANTHOPS[1] n. g.

Type: *Aphilanthops frigidus*; (*Philanthus frigidus* Smith, Cat. Hym. Brit. Mus., IV, 475, ♂).

♂. Front above the antennae not prominent; antennae inserted above the middle of the face, and distant from the clypeus, approximate; sides of the clypeus limited above by a transverse suture, and with no suture separating them from the median lobe, not attaining the eyes laterally; edge of the clypeus laterally with a loose fringe of erect hairs, the face pubescent, edge of clypeus three-toothed; labrum concealed, its breadth twice as great as its length, slightly sinuated in the middle of the anterior margin; mandibles slender, without teeth; eyes entire. Venation of anterior wings as in *Philanthus*, but the second submarginal cell shorter, and the third submarginal cell more narrowed towards the marginal than is usual in that genus; the submedial cell of posterior wings falling far short of the medial cell on the externo-medial nervure. Anterior tarsi with a short fringe of bristles; posterior coxae with the apophyses minute and slender; the tibiae not sharply serrate, and the posterior femora not terminating in a flange. Segments of the abdomen slightly constricted, first segment not nodose; apical segment with no enclosed area or disk, depressed; the eighth ventral segment extending beyond the seventh dorsal.

♀. Agrees with the male in all except sexual characters, and the following: edge of the clypeus with five prominent teeth; anterior edge of labrum straight, not sinuate; anterior tarsi fringed with long spines; a flattened and very broad enclosure on the sixth dorsal segment.

To this genus it is probable that *P. laticinctus* Cress., and *P. albopilosus* Cress. also belong.

From *Nectanebus* Spin. which this genus resembles in many respects, *Aphilanthops* differs in the pointed marginal cell, in the approximate antennae, in the absence of an enclosure on the apical segment of the abdomen in the male, in the enclosure present in the female being unlike that of *Cerceris*, in the shorter ciliation of the anterior tarsi of the male and the simple posterior tarsi of the male.

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[1] ἀ, φίλος, ἄνθος, ὤψ.

In the entire eyes, the approximate antennae inserted high above the clypeus, the flat front of the male, the erect fringe on the clypeus of the male, and the short submedial cell of the posterior wings, this genus differs from *Philanthus* and agrees with *Cerceris* and *Eucerceris*. In the other characters the male agrees with *Philanthus* (or, rather, with the American section of that genus which has been named *Cheilopogonus* by Westwood and *Anthophilus* by Dahlbom); but the female differs from *Philanthus* in the 5-dentate clypeus, the straight edge of the labrum, and the presence of an enclosure on the sixth segment of the abdomen.

The anterior tarsi of *Philanthus* are armed externally with a fringe of long spines, and the male to some extent shares this character with the female, the spine at the apex of the third joint extending well beyond the tip of the fourth joint. In both sexes of *Cerceris* these spines are short, and the tarsal joints are more robust than in *Philanthus*. In these characters *Aphilanthops* ♂ is intermediate, the tarsal joints not being so robust as in *Cerceris*, and the spine at the tip of the third tarsal joint, extending only to the tip of the fourth joint; but the female of *Aphilanthops* agrees with *Philanthus*.

The antennae of *Aphilanthops* are not so closely approximate at their insertion as in *Cerceris*, and some species of *Eucerceris*, but are as close as in *Euc. canaliculatus* (Say), and *Euc. superbus* Cress.

The labrum of *Aphilanthops* ♂ is smaller than is usual in *Philanthus* ♂, but is not, as in the ♂ of *Eucerceris* and *Cerceris*, a mere transverse border of the membranous lobe which lines the under side of the clypeus. In *Philanthus* ♂ the labrum has a median notch or sinuation. In the female of *Philanthus* the labrum has three slight sinuations on the anterior margin, that in the middle being narrow and sharp. In *Cerceris* ♀ the margin of the labrum is tri-sinuate or tri-emarginate. The median sinuation is commonly broad and shallow (as in *bicornuta*, *nigrescens*, *clypeata* and *dentifrons*); the lateral sinuations may be slight (as in *nigrescens*, *clypeata*, etc.), or as large as the median sinuation (as in *bicornuta*) and angular.

In *C. compar* the labrum of the female is much produced, the median portion produced the most, and the median sinuation replaced by an angular notch; and the labrum of the male is almost as large as is the labrum in the female of other species. The labrum of *C. compacta* Cress. ♀ is similar to that of *compar* ♀ in outline, but the lateral sinuations are much deeper, and the side lobes of the labrum are separated from the median portion by a distinct angle which places them upon a lower plane; the median lobe is dark testaceous, the side lobes semi-transparent. In the male of *compacta*, the labrum is not enlarged; the median lobe of the clypeus is greatly narrowed, almost pointed, at the tip. In *Cerceris fumipennis*, the labrum is unusually large in the ♂; in the ♀ it differs from all others examined, in having only one broad sinuation as in *Eucerceris* ♀. Of *fumipennis*, *C. unicincta* Tasch., Giebel's Zeit. XLV, 397, ♀ (1875), is a synonym.

Cerceris mandibularis n. sp.

♀. Length 9 mm., expanse 15 mm. Slender, the wings long. Black, base of mandibles, sides of face, two dots on clypeal process, spot below insertion of antennae, and spot on scape beneath, two dots on scutellum, tips of femora, tibiae and tarsi, of four anterior legs, stripe on tibiae of posterior legs, and narrow fasciae on the second, third, fourth and fifth segments of the abdomen (that on the second segment broadest, and that on the fifth segment slightly interrupted, and all the fasciae narrowed on disk), yellow. Tips of mandibles, basal joints of flagellum beneath, tip of the apical joint of antennae, the tegulae and tip of posterior femora, testaceous. Wings subhyaline, the anterior margin beyond stigma clouded, violaceous. The mandibles expanded on the middle of the inner edge, the expansion broadest in the middle, and bearing three slight teeth. Side lobes of clypeus silvery pubescent, margin of median lobe armed with two blunt teeth between which is a broad expansion; base of clypeus bearing a broad truncated process, the face of the truncation flanged beneath, and forming an arched, slightly excavated and highly polished surface. Body strongly punctured; a sharp ridge between antennae, enclosure of metathorax puncto-striate; first segment of abdomen longer than broad, with the appearance of a slight sinus in the middle of the lateral margin when viewed from above, the segment only half the width of the following segments; the sinus in the sixth ventral segment no deeper than it is broad at the apex. Waterbury, Conn., Aug. 14th.

♂. Face below antennae, dot on tegulae, spot on posterior coxae, the four posterior trochanters, posterior femora beneath, and the posterior tibiae yellow. Tips of posterior tibiae above the posterior tarsi, and dot on each side of ventral segments two to five, sometimes testaceous; in one specimen all the femora, except at base, reddish yellow. Tip of antennae and the scutellum black. The fascia on second abdominal segment broader than in the female, and a broad fascia on the sixth segment. More coarsely punctured than the female, the punctures almost confluent on thorax beneath and behind. A sharp tooth on the inner margin of the mandibles; sides of the clypeus with a long silvery pubescence, that at the apex forming the "moustache"; side lobes small, a black dot at the junction of the foveal suture with the median lobe, this dot in one specimen connected by a line with the broad black margin of the clypeus; in the other specimen the black margin narrower; median lobe much produced and narrowed at apex, the tip slightly bisinuate. Eighth ventral segment slightly emarginate at tip, its angles not extending beyond the seventh dorsal segment. Waterbury, Conn., July 14, and Southington, Conn., July.

Resembles *C. deserta* Say, but is not allied. In the expansion of the mandibles it resembles *C. compar*, but the expansion is not so great as in that species; the labrum of the male is small as is usual in Cerceris, and the labrum of the female is not apparently enlarged. In form and appearance the species is very unlike *C. compar*.

Cerceris compar Cress.

In coloration, the male of this species (which is common in Connecticut) varies from the typical form in having a continuous yellow line on the scutellum, in having the pectoral spines tipped with yellow, in the fasciae on the abdomen being broader (that on the first segment being of even width and those on the other segments being considerably dilated at the sides), and in having a narrow twice-interrupted fascia on the second and third ventral segments. The anterior coxae entirely, the four posterior coxae at the base, and a spot on the four anterior tibiae beneath, are black. The foveal suture is delicately marked with black.

The female, hitherto undescribed, closely resembles the male. The coxae and trochanters are black, the posterior tibiae are yellow, with a black stripe on the apical third within, and the fasciae on the fifth, fourth, and sometimes the third abdominal segment, are whitish. The foveal suture is broadly black, and the angular depression beneath the insertion of each antenna is black.

The species presents many structural peculiarities, and constitutes a distinct section in the genus. The basal segment of the abdomen is not nodose, but is short and broad, gradually increasing in size from the base to near the apex. In the male there is a stout recurved tooth on each side of the breast, and in the female the median lobe of the clypeus is not produced, but is more convex than in the male, and the side lobes are clothed with a silvery pubescence, which forms a fringe on the margin corresponding to the "moustache" of the male. The side lobes of the clypeus are small, suborbicular, separated from the median lobe by a short suture, and having a slightly oblique suture above. In the male the margin of the clypeus is narrowly and slightly produced, the apex slightly bisinuate; in the female the margin is more broadly and less suddenly produced, and the apex is less distinctly bisinuate. The labrum is black, its form is described above. The mandibles of the female are expanded on the middle of the inner border, the distal portion of the expansion the greatest and separated from the apex of the mandible by a large triangular notch, the inner face of the expansion armed with three short teeth. In the male the mandibles have on the inner margin a broad sharp tooth corresponding to the expansion of the female. The eighth ventral segment of the male is broadly emarginate at the tip and sometimes advanced beyond the dorsal area. The sixth ventral segment of the female has a deep and broad sinus at the tip. The marginal cell and the wings as a whole are often shorter than is usual in the genus.

With regard to the preceding paper, page 368, by Mr. Crosby, Dr. Wadsworth remarked that Mr. Crosby had evidently misunderstood certain of his objections raised in the former discussion, and further, that in his view nothing shown or advanced concerning the Brighton locality calls for any modification of his former statements.

The Secretary announced the award by the Council of the Walker Grand Honorary Prize for 1879 to Dr. Joseph Leidy, of Philadelphia, for his prolonged investigations and discoveries in Zoology and Palaentology. The amount awarded was $1000.

Section of Entomology. January 28, 1880.

Mr. S. Henshaw in the chair. Seven persons present.

The following papers were read:—

PAPERS ON GALLS IN BOTANICAL SERIALS. BY DR. H. A. HAGEN.

In the "Botanischer Jahresbericht," by Dr. L. Just, Berlin, 1879, recording the botanical literature for 1877, the section (pp. 485-517) on galls of plants produced by animals is edited, as in former years, by Dr. F. Thomas, well known for his numerous and valuable communications upon the subject. Of the 107 papers recorded (one fourth on Phylloxera), relating to the classification, to the physiology and the terminology of galls, some are published in botanical serials not easily accessible to entomologists, and in fact not recorded in zoological papers. I therefore believe that a condensed sketch of the contents of three papers by Mr. M. W. Beyerink may be of some importance for North American specialists.

1. Ueber Pflanzengallen, in A. de Bary's Botanische Zeitung, vol. 35, pp. 17-21 ; pp. 33-38. This paper proposes a natural classification of galls.

2. Bijdrage tot de morphologie of the plantgallen. Utrecht, 1877. 8°, pp. 92, pl. 2. This paper seems to be partly an introduction to the foregoing. I was not able to see the paper, and have used the record by Dr. M. Treub given in the Botanischer Jahresbericht.

3. Over gallen aan Cruciferen, in Nederlandsch kruidkundig Archief. Nijmegen, 1877, 8°, ser. 2, vol. 3, p. 164-173.

In the second paper, Mr. Beyerink comprehends under the name galls every abnormal new formation of plant cells or plant tissues, produced by some vegetable or animal matter, which is introduced partly or entirely in the interior of the plant. As gall-producing plants, he considers Algae, Fungi and, in the Phanerogams, the Rafflesiaceae and the Loranthaceae ; as gall-producing animals, Rotatoria, perhaps Infusoria, Nematoda (Anguillula), and Arthropoda.

The first paper contains the following proposed classification.

Class I. Galls with unlimited growth.

Several generations of the tenants produce the gall, which was first began by a single full grown individual. Nutrition and propagation of the tenants take place in the gall.

- Order I. External galls. The tenants do not penetrate the plant with their body.
  - Family I. Hemipterous galls, deformations of the leaves ; some tenants build dimorphous galls, on different parts of the plant (Phylloxera, Brachyscelis).
    - Group 1. Galls with centrifugal growth, simple or compound. The gall develops in a direction away from the tenant (Chermes, Psylla).
    - Group 2. Galls with centripetal growth (Pachypappa).
  - Family II. Phytoptus galls, simple or compound.
- Order II. Internal galls. The tenants penetrate with the whole body into the interior of the plant, where nutrition and propagation takes place.
  - Family I. Some Phytoptus galls.
  - Family II. Anguillula galls.

Class II. Galls with limited growth. One or more tenants inhabit the galls only during the period of development of the imago.

- Order I. Larva galls ; egg deposited externally ; the larva penetrating into the plant.
  - Family I. External galls, simple or compound (Cecidomyia).
  - Family II. Internal galls—or inflated mines, or swellings, or deformations of the flower or of the fruit, or entirely closed larva galls (Diptera, Lepidoptera, Coleoptera).
- Order II. Imago galls. The imago pierces the plant, and deposits the egg in its interior parts (Hymenoptera.)
  - Family I. Tenthredinidae.
  - Family II. Cynipidae.

I have tried in the foregoing sketch to combine in some way the views of Mr. Beyerink with those of Dr. F. Thomas, given in the Jahresbericht and in some other papers. The principal division in the two classes accords, indeed, very well with a general classification of the galls from a zoological standpoint, but the growth of the gall in the first class is not always unlimited, and depends in the case of galls on leaves, upon the age and vigor of the leaf. Probably the difficulty will be corrected by better phraseology. The first class contains the galls of Hemiptera and Acari besides the galls of other animals than Arthropoda, and plants. The second class contains all galls of Diptera, Lepidoptera, Coleoptera and Hymenoptera.

The farther division into external galls and internal galls is not a new one, but agrees well with the facts. To the first belong all Hemiptera and most of the Acari, to the second some Acari and Angaillula.

The divisions of the second class are called "Mantelgallen" and "geschlossene Gallen" by Mr. Beyerink. I have adopted, according to Dr. Thomas' views, the expressions used in the first class.

The division of Larva galls and Imago galls by Mr. Beyerink is apparently correct, though some of the galls are not put by him in the right place. The external galls of the larva class all belong to Cecidomyia; the internal galls, subdivided by Mr. Beyerink into two groups and several sub-groups, contain some Diptera and all Lepidoptera and Coleoptera. The imago galls contain all Hymenoptera. Here again objection is made by Dr. Thomas to the expressions used for the Cynipidae. Indeed these galls are often not full grown, before the larva is hatched from the egg.

Mr. Beyerink gives with every group and sub-group the number of species of galls known to him. There are mentioned for Hemiptera 66; Acarus about 111; for Diptera 177, three-fourths of them Cecidomyia; for Lepidoptera 14; for Coleoptera 36; for Hymenoptera 130, 16 of them Tenthredo.

I should state that most of these figures include only the European species, except in the case of the Cynipidae.

For those students not yet acquainted with the rational nomenclature proposed six years ago by Dr. F. Thomas, I add his principal names. The term *Cecidium* includes every deviation in the development of plants, and, therefore, comprehends not only the true galls, but also the false galls and the hypertrophies to the phyllomania. Cecidium is divided into *Acrocecidium*, the bud-galls and all related to them; and *Pleurocecidium*, all the rest. Dr. F. Thomas remarks that in Mr. Beyerink's classification the simple galls belong mostly to Pleurocecidia, the compound galls to Acrocecidia. All animals producing galls, are named *Cecidozoa*; all plants producing galls, *Cecidophyta*. It is obvious that such a uniform nomenclature has a decided advantage over the older one.

The third paper of Mr. Beyerink will probably be useful to American students, as the galls produced on our Cruciferæ will be found nearly related to those of Europe. Mr. Beyerink describes four fungi as producers of hypereropthis; four Diptera, three of them Cecidomyia, and one Agromyza doubtful; one Hemipteron, the well known *Aphrophora spumaria*; five Coleoptera, all weevils; and some Phytoptus.

It is of course impossible to give an extract of the condensed record of Dr. Thomas, but for American Entomologists, it will be of interest to know that the new genus Colopha (*Thelaxes ulmicola* Walsh) of Mr. J. Monell, Canad. Entom., vol. IX, is identified as the common European species *Tetraneura ulmi.*

Prof. O. Nickerl has published a record of the insects observed to be obnoxious to farmers in Bohemia, during the year 1878. There are two facts probably of some value for N. American farmers. The sugar beet is extensively damaged by larvae of different species of Silpha. These larvae are commonly considered to be carrion-feeding, but it was shown by experimenting, that though not avoiding meat or carrion, they will leave this kind of food when plants are at hand. Farther experiment showed that some weeds were preferred by the larvae to the sugar beet. Therefore Mr. Nickerl recommends farmers not to clear the fields entirely of these weeds. As two of them, *Chenopodium album* and *Atriplex platula*, are very common here, it is possible that they would here in the same manner be attractive to obnoxious larvae.

Farther it was observed that many injurious moths, principally those with hairy caterpillars, have the habit of depositing the eggs in the interior of bird-houses. Therefore it is recommended to clear such houses carefully before the spring. I may remark that in Germany such cleaning is done regularly, as it has been observed that birds avoid the uncleaned houses.

NOTE ON A SARCOPHAGOUS LARVA FOUND IN A GIRL'S NECK.

BY DR. H. A. HAGEN.

I lately received from Mr. R. R. Wright of Toronto, Canada, the skin of a larva extracted from a swelling in the neck of a girl.

The larva belongs to the genus Sarcophaga, and there are known at least seven cases, where sarcophagous larvae have been extracted living from the eyes, nose and ears of man. Mr. J. F. Ruthe-

(Wiegmann, Handb. der Zool., 1832, p. 438), records that the larva of *S. latifrons* has been cut out of abcesses in the ears of man, in Berlin, Prussia, several times, though the imago is rather rare there.

Prof. E. Grube (Wiegmann Archiv, 1853, Vol. XIX, T. 1, p. 282-85), records three cases. Two boys, four and twelve years old, had slept in the open field in Gorigoretzk, Russia, and felt in wakening up some pain in the inner angle of the eye. There followed inflammation destroying the eye, and the physician extracted twelve to fifteen larvae, nine lines long. Some of them transformed later to flies, which Prof. Grube determined to be Sarcophaga, and either *S. latifrons* or *S. ruralis*. Another case observed by the same physician, Dr. Schnee, was that of a Jewess. Out of an abcess in the nose several larvae were extracted. Dr. C. J. Blake (Archives of Ophthalm. Otology 1872, vol. 2), recorded four cases of extraction of living larvae out of the human ear, three Sarchophaga, one Lucilia. Of the Sarcophaga five and four larvae were extracted, of Lucilia one.

Concerning the species of the larva found in the neck of the girl, nothing definite can be said. According to the latest authorities, Baron Osten Sacken and Mr. Meade, the presence of *S. carnaria* in the United States is not yet proved. I must quote here the statement of Bouché, a first-class authority, that he never found the larva in rotten meat, but in rotten vegetables, and in dung — according to Fallén, it lives in horse dung.

The N. American species of Sarcophaga are not yet worked out. Mr. Meade, the latest monographer, has examined them carefully, and separated twenty-four species, but not named them. The section corresponding with *S. latifrons*, contains six species, but every one is stated to be unlike any British species. I remark that *S. latifrons* does not occur in England, but its nearest related species, *S. affinis*.

General Meeting. February 4, 1880.

The President, Mr. T. T. Bouvé, in the chair. Twenty-seven persons present.

After the usual opening of the meeting the President said:

Since we last met the Society has lost one of its oldest and most valued members, Dr. Thomas M. Brewer.

It grieved me as an old personal friend to learn, when in a distant State, that the disease, by which as I knew before leaving home he was prostrated, had terminated fatally and that I should not again receive his pleasant greeting on earth, or even have the sad satisfaction of being present at the funeral services following his departure. The long intercourse between us had always been of the most agreeable character, and I feel that I have reason to mourn that it has so unexpectedly and sadly terminated. This is not the place, however, for me to indulge in the expression of personal bereavement, but rather to dwell on the great loss the Society and the community have met in the death of our beloved associate.

Dr. Brewer was born in Boston, Nov. 21, 1814. He graduated at Harvard College in 1835, and in the Medical School in 1838. He labored in his profession for several years, but his tastes and inclinations were stronger for other pursuits. He was fond of literary labor, and, having strong political tendencies was early led to write for one of the leading Whig papers of the period, the Boston Atlas, and at length to become one of its editors, in which capacity he manifested marked ability both as a writer and close observer. Subsequently he became interested in the firm of Swan and Tileston, a publishing house which afterwards changed its title to that of Brewer & Tileston. He retired from business in 1875 and then visited Europe where he remained two years. He had become well known by his ornithological labors and received consequently very gratifying attention from many distinguished scientific men whilst abroad.

In the cause of popular education he was very zealous, manifesting at all times great interest in the public schools of the city. He was long a member of the Boston School Committee, and served in this capacity with great devotedness. His last election to this office was in 1879 for the term of three years.

Dr. Brewer was elected a member of this Society Oct. 7, 1835, and soon became well known by his valuable contributions, mostly upon his favorite pursuit of ornithology. It is pleasant to recall the fact that his first communication to the Society was in defence of Nuttall and Audubon, the distinguished naturalists, the latter his warm personal friend, against some unjust attempts in a foreign magazine to detract from their well earned and deserved reputation. Not long after he presented a highly interesting paper upon the Birds of Massachusetts, in which he gave an account of over forty species not embraced in the State report of Dr. Hitchcock upon the Geology and Natural History of the State. From that early period, now nearly half a century since, he never ceased to manifest great interest in the welfare of the Society, by frequent communications and in such other ways as his health and time would admit.

Apart from what he performed for the Society he accomplished much for scientific knowledge by contributions to several publications of great value, and by articles which he furnished for some of the popular magazines.

As these remarks will be supplemented by particular mention of Dr. Brewer's scientific writings in a sketch furnished by his friend Mr. J. A. Allen, it will not be necessary for me to make further reference to them, and I need only add that, had he lived free from the business cares that until recently absorbed most of his time, much more might have been looked for from him relative to the habits of birds, particularly of such as find a home permanently or temporarily n New England.

We of the Society will greatly miss his efficient labors in striving to complete the collection in the department of New England Ornithology, for the development of which he manifested much and increasing interest.

In the death of Dr. Brewer our Society has truly lost a most valuable member, and the community, a good and wise citizen, one of whom it may be truly said: He was always faithful to the duties of every position in which he was placed and ever ready to work where he recognized that his labors would promote the public welfare.

The following notice of Dr. Brewer's scientific labors by Mr. J. A. Allen was also contributed.

The death of Dr. Brewer removes another of the older American ornithologists, of whom there now remain two only whose period of scientific activity extends back to the time of Audubon and Nuttall. Dr. Brewer's first formal contribution to ornithology, entitled "Some additions to the Catalogue of the Birds of Massachusetts in Prof. Hitchcock's Report, etc," was published in 1837, in the first volume of the "Journal" of this Society. These additions numbered forty-five species and increased by one-fourth the list of birds previously known as inhabitants of this State. Previously, however, he had furnished valuable notes and rare specimens of birds to Audubon, who, in his great work on North American birds, makes frequent mention of his indebtedness to his "young friend, Mr. T. M. Brewer of Boston."

In 1840 he became more generally known as an ornithologist through his edition of Wilson's "American Ornithology," — the only American edition of Wilson's work, except Ord's, published prior to 1871. The "Brewer edition," from its comparatively small cost, placed this delightful work within the reach of a wide circle of readers, to whom the more expensive original and Ord editions were inaccessible. It was enriched by the addition to the original text of the synonymy and critical commentary of Jardine's edition, and by a very useful and carefully digested synopsis of all the birds at that time known as North American.

In 1857 was published the first part of his "North American Oölogy," which forms part of volume IX of the "Smithsonian Contributions to Knowledge." The full title of the work — "North American Oölogy; being an account of the geographical distribution of the birds of North America during the breeding season, with figures and descriptions of their eggs"—indicates very fairly its scope and character, but in addition to the topics thus indicated, the work gives a pretty full exposition of the breeding habits of the species treated, so far as then known, and also full tables of synonymy. Owing to the great cost of the illustrations, the work was not continued beyond the first part, which treats of the Birds of Prey, the Swifts, Swallows, Goatsuckers and Kingfishers. This work, until within the last year, was the only special treatise extant on the subject to which it relates, and will ever hold the place of a standard work. It is, moreover, a work which brought to its author great credit, and through which he became widely known as an ornithologist of high standing.

In 1874 appeared "A History of North American Birds," under the joint authorship of S. F. Baird, T. M. Brewer, and R. Ridgway, in three quarto volumes devoted to the "Land Birds." To this work the whole of the biographical part, forming probably two-thirds of the letterpress, was contributed by Dr. Brewer, and throughout evinces his thorough familiarity with the literature of the subject, and shows the hand of the master in all that relates to his special department of a work which marks an era in the history of North American ornithology.

Dr. Brewer's minor papers appeared at intervals throughout the long period of over forty years, and embrace important contributions to our knowledge of American birds.

He has left the manuscript for the completion of his share of the great work on North American birds already mentioned, the final revision of which he had just completed;

also material for the contemplated continuation of his "North American Oölogy." His collection of eggs—the accumulation of a long series of years, and doubtless one of the best private collections extant,—has become the property of the Museum of Comparative Zoölogy.

Dr. Brewer having been engaged during the larger part of his life in absorbing professional or commercial pursuits, his contributions to ornithology must have been largely the work of such limited time as could be spared from his business engagements, and only within the last few years was he able to devote himself wholly to his favorite studies. Although an authority of unsurpassed eminence in his special province, — that of North American oölogy, — his labors were mainly restricted to this field, taken, however, in its broader sense. Removed suddenly, apparently when there were years of activity and leisure before him for scientific research, his loss is one not easily replaced, nor its importance readily to be appreciated, except by those who knew him intimately and were familiar with his conscientious manner of investigation, his warm sympathy, and the thorough loyalty of his friendship.

Dr. J. W. Fewkes read a paper on the pinnal suckers of some Heteropods, and described some cases of parasitism among Acalephs, in one of which the host is a Heteropod.

Mr. F. W. Putnam read a chapter, relating to the Indians of California, from a forthcoming volume of Lieutenant Wheeler's Survey.

The President showed some minerals which he had presented to the Museum as a part of a collection showing physical characteristics of minerals.

Letters from Dr. J. Leidy, acknowledging and returning thanks for the award to him of the Grand Walker Prize, and from Dr. Hans Bruno Geinitz of Dresden, acknowledging his election as Corresponding Member, were read.

General Meeting. February 18, 1880.

Vice President, Mr. S. H. Scudder, in the chair. Forty-one persons present.

The following papers were read:—

THE AMYGDALOIDAL MELAPHYRE OF BRIGHTON, MASS.

BY E. R. BENTON, PH.D.

The earliest observations upon the melaphyre rocks commonly known as the Brighton Amygdaloid, were published some seventy years ago.[1] They were made by Mr. S. Godon, a Frenchman, who, in the course of his description of the Geology in the vicinity of Boston, says of this rock : The conglomerate (*i. e.*, the Roxbury pudding-stone,) "commonly unites with the amygdaloid by an insensible transition."

In the year 1818,[2] J. F. and S. L. Dana described the amygdaloidal rocks in the vicinity of Boston, and applied to that variety which is found in Brighton, the name *variolite*. They say with regard to the derivation of the name variolite, that this rock "is a variety of Amygdaloid, produced by the decomposition of the basis, whereby the nodules (*i. e.*, the amygdules), project from the mass; from the fancied resemblance to the small-pox (or varioloid) pustule, the name Variolite has been given to it."

In 1825,[3] Dr. J. W. Webster published the statement that the passage into each other of the conglomerate and the amygdaloid could be satisfactorily observed in several places in the town of Brighton.

In 1833,[4] Dr. Edward Hitchcock in a Report on the Geology of Massachusetts called this rock merely a variety of the conglomerate, and again in 1835,[5] and 1844,[6] he classes it under Graywacke, meaning thereby the Roxbury conglomerate, and gives to the amygdaloid the name of varioloid wacke. He says : "At a quarry about a mile southwest of Brighton Meeting House, this varioloid rock may be seen passing into conglomerate, showing that it is only a variety of the graywacke formation."

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[1] Mem. Am. Academy, III, 150. 1809.

[2] Mem. Am. Academy, V, 208. 1818.

Bost. Journ. Phil., III, 487. 1825.

[4] Am. Journ. Science, XII, 33. 1833.

[5] Report on Geol. of Mass., 1835.

[6] Final Report on Geol. of Mass., 1841.

Coming down to 1870,[1] Dr. T. Sterry Hunt states in the Proceedings of this Society, that the amygdaloid of Brighton is a crystalline, stratified rock.

All these writers regarded the amygdaloid as a stratified rock, and three of them assert that it passes by a gradual transition into the Roxbury conglomerate, and consider it to be merely a variety o that rock.

In a paper by Mr. W. W. Dodge,[2] published in the Proceedings of this Society in 1875, these rocks are treated as hornblendic. The writer had observed in various places their contact with the conglomerate series, and therefore regarded them as being, at least in part, of eruptive origin.

In January, 1879,[3] Prof. N. S. Shaler read before this Society a paper in which he said: "It seems to me that these rocks afford evidences that the shales and conglomerates of the Roxbury series pass at certain points into an amygdaloidal trap which has been ejected through the overlying beds."

"With care and with favorable conditions of the quarries the observer may trace the stages of this transition from the faintest beginning of the amygdaloidal structure in rocks which are distinctly conglomerates, into rocks where the blebs (or amygdules) have been so completely developed, that every trace of the original pebbly structure is now lost and the mass converted into an amygdaloidal trap."

Thus all the writers on the amygdaloid with the exception of the Dr. Dana, Dr. Hunt and Mr. Dodge, maintain that there exists a gradual transition between that formation and the Roxbury conglomerate.

It is to be observed, however, that there is a radical difference between the cause assigned for the transition by the earlier writers and that assigned by Prof. Shaler; for the former merely considered the two rocks as of common origin, while the latter maintains that the one rock originated *from* the other; that is to say, that we have here an instance of the transformation of a sedimentary rock into an igneous one.

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[1] Proc. Bost. Soc. Nat. Hist., XIV, 45. 1870.

[2] Proc. Boston Soc. Nat. Hist., XVII, 416. 1875.

[3] Proc. Bost. Soc. Nat. Hist., XX, 129. 1879.

DESCRIPTION.

The amygdaloid rocks under consideration lie in the eastern part of the Brighton district of Boston, between North Beacon Street on the north, the Brookline boundary and Washington Street on the south, and Market Street on the west.

They occur in the shape of two nearly continuous ridges, (see map), which are very variable in direction, in height, and especially in width. The general direction is about east and west, the length of the more northerly about *three-quarters of a mile*, that of the more southerly *half a mile*. The width at the head of the lane leading to Allston Heights is about 60 feet, while measured along Allston Street, it is 350 feet. These ridges of amygdaloid rise above the surrounding stratified rocks from 20 to 50 feet.

The stratified rocks lie to the north and south of, and between the ridges of amygdaloid. Their strike is about W. N. W., and E. S. E. Thus it is not the same as the direction of the ridges of amygdaloid. The dip is about 30° to the E. N. E.

These rocks, though all belonging to the same geological series, are of two very distinct kinds : First, the fine-grained fragmental rocks, *i. e.*, the argillite and fine-grained sandstone. Second, the genuine conglomerate, which is composed chiefly of quartzite, felsite, granite, gneiss, syenite, and argillite pebbles, which are usually, at least, an inch or two in diameter. In this latter rock a few irregular layers of fine-grained sandstone are interbedded. The pebbles of the conglomerate are held together by a cement composed of the same materials as the pebbles themselves, though of course in a finely divided state.

A part of the conglomerate lies to the north, and a part to the south of the sandstone and argillite formation, the thickness of these intervening rocks being eight to nine hundred feet.

Most of the sandstone and argillite is massive, but at the head of the lane leading to Allston Heights, the argillite is fissile, and on Warren Street, opposite the small powder magazine, the sandstone is in the same condition. It also bears very perfect ripple marks, which show that the waves which made them came from a direction a little east of north.

With regard to the *relation* of the amygdaloid to the argillite sandstone and conglomerate, in a word to the stratified rocks, it may be said at the outset that in every spot where overlying soil does not prevent, the *contact* between the igneous and the stratified rocks has been found. It is not always easy to find, but when found the line of demarkation is very sharp, and the contact phenomena very characteristic.

This line of contact has been observed in at least ten different places. In most cases the amygdaloid abuts against the argillite, but in some cases against the sandstone, while in one case it is found in contact with the conglomerate itself.

At the Pumping Station quarry, the contact on the north side is a very irregular one; the argillite has been baked by the heat of the melted amygdaloid matter to a great degree of hardness; its color has been changed from gray to a reddish brown; angular fragments of it are included in the igneous rock.

Just west of the Pumping Station, close to the sidewalk on Cambridge Street, the line of contact is visible for fifty feet, and here the *plane* of contact of the two rocks seems to have an inclination to the horizon of at least 15° more than that of the beds of sandstone and argillite. The same hardening of the argillite occurs here, and its color is altered in a similar manner.

Under the microscope the line of contact is still more distinctly seen than in the quarry or in the hand specimen. The igneous substance penetrates between the grains of the fragmental rock, and also incloses minute fragments broken off from the latter.

At the quarry behind the carriage factory on Allston Street, occur beds of argillite resting on the amygdaloid, and it is seen that they have been tilted up by the pressure of the igneous matter.

At the head of the lane leading to Allston Heights, and near the small powder magazine on Warren Street, it can be seen that the amygdaloid has broken through the argillite and sandstone, and here the same hardening and change of color have taken place.

Under the microscope, small tongues of the igneous matter are seen penetrating the fragmental rock, and the minute elongated feldspar crystals, with which the amygdaloid rock is filled, are seen to be arranged parallel to the line of contact. These crystals were already formed before the moment at which the rock solidified, and, as would naturally be expected, were forced to take a direction perpendicular to the resisting force.

A case of the contact of the igneous rock with the conglomerate itself has been spoken of; this occurs on the west side of Howard Street, near North Beacon Street, the amygdaloid formation being bordered on the south side, between Harvard Avenue and Allston Street, by a mass of conglomerate. Here the contact is just as sharp as in the other localities, and an arm of the amygdaloidal rock has forced itself into a fissure in the conglomerate.

The phenomena of contact which have now been cited make it evident that the amygdaloid is an eminently intrusive rock. In no case has it been found distinctly interbedded with stratified rocks. On the contrary, in the Pumping Station quarry it has been observed that the plane of contact is not coincident with the stratification, and in the quarry behind the carriage factory on Allston Street, that it has upheaved the argillite. Hence it is probable that the igneous rock has not in general been driven in between the strata, but has rather broken through them along joint planes and fissures.

The color of the amygdaloid is either dull purplish or dull greenish gray. It is a soft rock and its powder is usually magnetic. Its fissures and irregular cavities are coated with quartz, chlorite epidote, calcite, and specular iron.

In its amygdules occur epidote, feldspar, quartz, calcite and chlorite. A few of the amygdules consist wholly of epidote, some wholly of feldspar. More commonly, however, the outer part is feldspar, while the interior is occupied by epidote. The quartz usually occurs in small quantities in the interior of an epidote amygdule, and the calcite and chlorite in minute quantities in the interior of feldspar amygdules — both rounded and wholly irregular amygdules occur.

Throughout a large part of the mass of this rock the amygdules exhibit no definite arrangement whatsoever, and in much of it no amygdules at all are to be found. This latter is the case in parts of the quarry at the Pumping Station, parts of the quarry opposite the carriage factory on Allston Street, in the exposure at the head of the lane leading to Allston Heights, and in the exposure opposite the small powder magazine on Warren Street. In certain parts of the formation, however, the amygdules are disposed in a definite manner.

One form of arrangement, the *banded*, consists in the grouping of great numbers of the amygdules into rather imperfectly defined wavy bands. This structure was noticed by Mr. Dodge in the quarry at the corner of North Beacon Street and Harvard Avenue. It is to be seen also in other localities. It is to be noted that the bands are not at all marked out by any difference in the ground mass which encloses the amygdules, but strictly by the occurrence and non-occurrence of the amygdules themselves. In another case, the *spherical*, great numbers of amygdules lie close together in spherical clusters. Here, also, there is no difference in the groundmass within, and that without the clusters.

In a third case, the *annular*, the amygdules are grouped so as to form concentric rings. Here again, both between the rings, and between the separate amygdules, the groundmass is the same as outside. In the centre, in many cases, is a cavity lined with minerals. This annular arrangement shows well in the quarry at the corner of North Beacon Street and Harvard Avenue.

In the fourth case, the *spheroidal*, a roughly spherical inclusion occurs, which differs from the surrounding mass only by a shade of color, and by being crowded with amygdules. The texture of both is the same, and they are strictly the same kind of rock. The surrounding groundmass penetrates the included fragment in many cases. (Harvard and Beacon, also, opp. Carrriage Factory.)

Fifth case — *the angular*, is like the preceding, except that the included fragments are angular. They are the same kind of rock.

Thus it will be seen that the different varieties of arrangement of the amygdules fall into two very distinct categories. In the *first* category, which contains the banded, the spherical and the annular arrangements, the groundmass between the amygdules is precisely the same as, and strictly continuous with, the great mass of the rock No line of demarkation exists between the groundmass within, and that without the group. In the *second* category, which includes the spheroidal and angular inclusions, the groundmass immediately surrounding the amygdules differs from that of the great mass of the rock merely by a shade of color. This difference, taken in connection with the sharpness of the line of demarkation, and the intrusive and penetrative character of the surrounding groundmass, makes it very probable that these bodies are *included fragments.* They are, however, fragments of the same kind of rock, their difference in color being due to a slight difference in the chemical changes which they have undergone since their consolidation.

Coming now to the groundmass of the amygdaloid in thin sections under the microscope, it is found to be composed chiefly of feldspar, magnetite, viridite and chlorite. Epidote, hematite, kaolin, and other earthy products of decomposition also occur.

The feldspar occurs throughout the rocks in ledged-shaped crystals, with steplike ends. Any two neighboring crystals usually make a considerable angle with each other, and it is common for them to include triangular spaces between them.

Many of these crystals show in polarized light that they are plagioclase. The rest have suffered chemical alterations into other minerals, but they still retain their characteristic shape and relative position. In none of the sections examined, have they been entirely obliterated. Thus they are in all respects similar to the feldspar crystals, which are peculiar to basaltic rocks. Many of them show in polarized light that they have been partially or wholly changed to a monoclinic feldspar, which is probably orthoclase; others have been converted into a pale green substance, which is in some cases viridite, in others chlorite. The magnetite occurs in grains and fine dust, usually in connection with the epidote. It is most abundant in the purplish part of the rock.

The chlorite and viridite in many sections make up the mass of the rock. They are more abundant in the greenish part of the rock. The epidote occurs in irregular grains, disseminated through the groundmass, as also do the kaolin, and other earthy products of alterations.

With the exception of the plagioclase feldspar, all the minerals which now constitute this rock are the products of chemical alterations which have taken place since the rock solidified.

Conclusions.

The shape of the plagioclase crystals, their arrangement, and the character of the alteration products which have just been described, stamp the amygdaloid as a melaphyre. As has been stated, its feldspars are in every respect similar to those which are peculiar to all basaltic rocks, and its principal alteration products are similar to those found by Dr. Wadsworth in certain less altered melaphyres and diabases occurring in Boston, Somerville and Malden. Also to those observed by Prof. Raphael Pumpelly in the amygdaloidal melaphyres of Lake Superior.

Prof. Pumpelly, Dr. Wadsworth, and Mr. S. Allport, have been able to trace the derivation of the alteration products from the original constituents of basalt. In the rocks now under consideration, it is, on account of the extreme alteration which they have undergone, impossible to do that, but we may safely infer that this rock was at the time of its solidification a basalt, and that its present variation from that rock is due wholly to subsequent changes.

The amygdules are also a subsequent product. In the great part of the rock they are not bounded by any well defined wall, and furthermore there is no arrangement of the feldspar crystals with reference to their boundaries. Cavities formed by gas bubbles would have a sharply defined wall, and the pressure of the gas causes the adjacent feldspar crystals to arrange themselves parallel to the boundaries of the cavities.

It is probable that nearly all these amygdules in the rock are rather pseudo-amygdules, formed not by infiltration into pre-existing cavities, but by a breaking up in spots of the original constituents, and the formation *in situ* of these new products.

A small proportion of them, however, show by their sharply defined walls, and by the arrangement of the surrounding feldspar, that they were formed in true gas cavities.

Reference has already been made to the supposition that the Brighton amygdaloid was derived from the Roxbury pudding-stone or conglomerate. As the derivation of so basic a rock from one so silicious, is on the face of it improbable, and as the writer's observations lead to quite a different conclusion, it is necessary at this point to consider the question more fully.

Prof. Shaler does not maintain that we can actually trace in the field a continuous gradation from the *unaltered* pudding-stone to the genuine melaphyre. Hence it is not necessary to enlarge upon the fact that the field observations demonstrate that no such continuous gradation is to be observed. His view of the matter can perhaps be best stated by further quotations from the paper already referred to. "We see in these localities (namely: exposure near small cemetery on Warren Street, and at the quarry corner of North Beacon St. and Harvard Ave.), a mass of conglomerate essentially the same as the Roxbury pudding-stone, only the pebbles and the cement have been greatly affected by heat so that the whole is more fused together than in the ordinary forms of that conglomerate. Looking closely we see that the matrix of the pebbles, and to a certain extent the outer part of the pebbles themselves, are filled with cavities in which . . . amygdules have been formed." "In the quarry on North Beacon Street there is evidence that some of the large boulders of the conglomerate have escaped the complete destruction arising from the expansion of the contained gases."

Thus the evidence for the transition rests upon the existence in the amygdaloid of the remains of pebbles of the pudding-stone, and upon the resulting supposition that parts of the amygdaloid are essentially the same as the pudding-stone.

The features in question have already been described in this paper (page 421) under the head of spheroidal and angular inclusions.

The objections to Prof. Shaler's conclusions are. First:—That the forms in question do not in any sense represent the pebbles of the pudding-stone. Second:—That no part of the amygdaloid formation is essentially the same as the Roxbury pudding-stone.

It may be said as a minor consideration that, whereas the pudding-stone is wholly made up of rounded fragments, on the other hand, large numbers of the inclusions of the amygdaloid are angular.

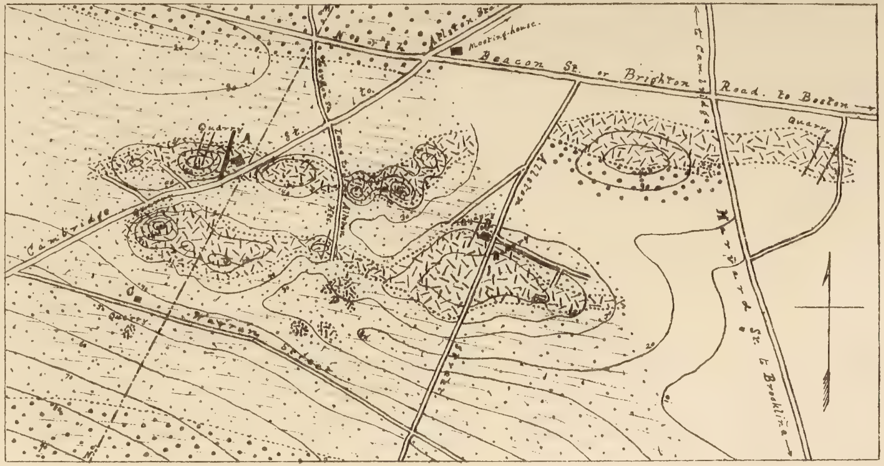
The two masses of rocks which have been cited as offering proof of the transition, are so different in their nature, that they must be treated of separately. That near the small cemetery on Warren Street is neither the amygdaloid nor the conglomerate. It is a fragmental rock made up chiefly of the debris of melaphyr rocks. This is shown by microscopic examination. A few of the constituent particles are quartzose or feldspathic, and there are a very few very small pebbles of quartzite or felsite scattered through the rock. Nothing can be proved from such a rock, since it is entirely different from both of those which are under consideration.

With regard to the other rock cited, *i.e.*, that at the corner of Harvard Avenue and North Beacon Street, even if it be granted that so far as the contours of the inclusions in question are concerned, this rock resembles the pudding-stone, it is impossible to consider them as the pebbles of that rock without entirely disregarding their lithological character, for every one of these bodies in the amygdaloid is now composed of the same kind of rock as that in which they are included, that is to say of melaphyr, an alteration product of basalt. This may be seen not only in the field, but in hand-specimens, and especially under the microscope.

The conglomerate is, as regards its constituents, an extremely heterogeneous rock. It contains pebbles of quartzite, felsite, granite and gneissic pebbles; also pebbles of syenite and clayslate.

It appears to be Prof. Shaler's supposition that, by the process of fusing, these lithologically different pebbles were all transformed into one and the same kind of rock, namely into melaphyre, or rather basalt, since what is now a melaphyre was, at the time it consolidated, a basalt.

Now, it is clear that the Roxbury conglomerate is a highly


Beacon St. or Brighton Road. to Boston →
← to Cambridge
Harvard St. to Brookline →
Quarry
Allston Street
Meeting-house
Lane to Allston Hts.
Cambridge St.
Warren Street
Quarry
A
B
C
M
N

Geological Map of the Amygdaloidal Melaphyre Rocks
of
Brighton, Mass.

Scale: 1000 ft. to 1 inch.

0 100 200 300 400 500 600 700 800 900 1000

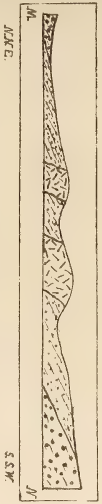
Contours 10 ft. apart vertically.

A. Pumping Station.

B. Carriage Factory.

C. Powder Magazine.

by
E. R. Benton. Ph.D.
1880.



Section
across the melaphyre rocks along
the line M N.

▨ Sandstone and Argillite.

▨ Roxbury Conglomerate.

▨ Amygdaloidal Melaphyre.

// Basaltic Dikes.

siliceous rock, since all the different kinds of rocks which occur in it to any considerable extent contain usually at least sixty per cent. (.60) of silica. The principal constituents of this rock, however, contain still more silica. The felsitic and granitic or gneissic pebbles are at least seventy per cent. (.70) silica, while the quartzite which enters so largely into the composition of this rock is nearly pure silica.

Thus it is safe to say that the conglomerate as a whole contains *at least* seventy per cent. (.70) of silica, while basalt on the other hand, contains only about forty-nine per cent. (.49) of silica, the highest analyses giving not over fifty-five per cent. (.55). Hence the change from one rock to the other would involve the removal of at least three-tenths ($\frac{3}{10}$) of the silica of the conglomerate. A further loss to the conglomerate of several per cent. of potash, and a gain in lime, soda, magnesia and iron would be among the other chemical changes necessary in order to have the proportion of the chemical constituents of the conglomerate made the same as that of basalt. So far as we know, however, the fusing of rocks does not materially affect the proportion of the chemical ingredients of the rock as a whole, and cannot change a highly siliceous rock to a highly basic one.

It seems probable then that the so-called pebbly structure in the amygdaloid cannot properly be regarded as evidence that any part of the amygdaloidal rock was derived from the pudding-stone.

Most of the bodies which have been called pebbles are included fragments of the same kind of rock as that which includes them.

This rock shows a tendency towards a concretionary structure — a secondary structure not yet explained, but known to occur in some other igneous rocks. In parts of this melaphyre, the spheroidal aggregations of amygdules already mentioned are to be referred to that structure.

Those bodies in the melaphyre which are truly included fragments, are probably the result of the breaking up of a pre-existing rock by a second intrusion of the same kind of igneous matter along the same path.

The occurrence of many of the spheroidal aggregations *as included fragments* seems to point to the fact that a spheroidal concretionary structure was already developed before the rock was broken up by the second flow; it thus had a tendency to break into spheroidal forms, and on consolidation of the whole, these bodies preserved ther spheroidal shape. This seems a possible explanation of these inclusions, although further investigations need to be made to test the validity of that supposition.

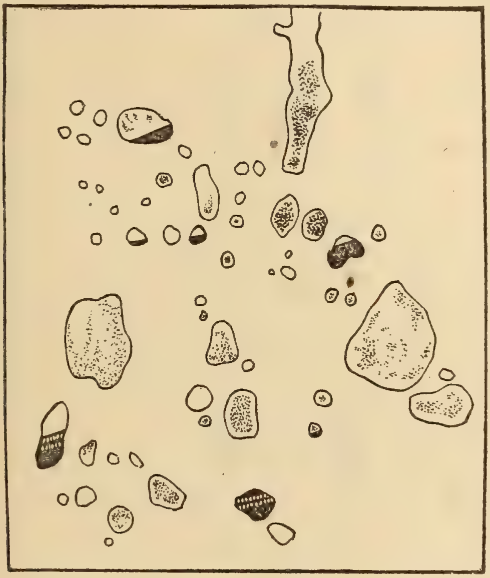
BANDED AMYGDULES OF THE BRIGHTON AMYGDALOID.

BY WM. M. DAVIS.

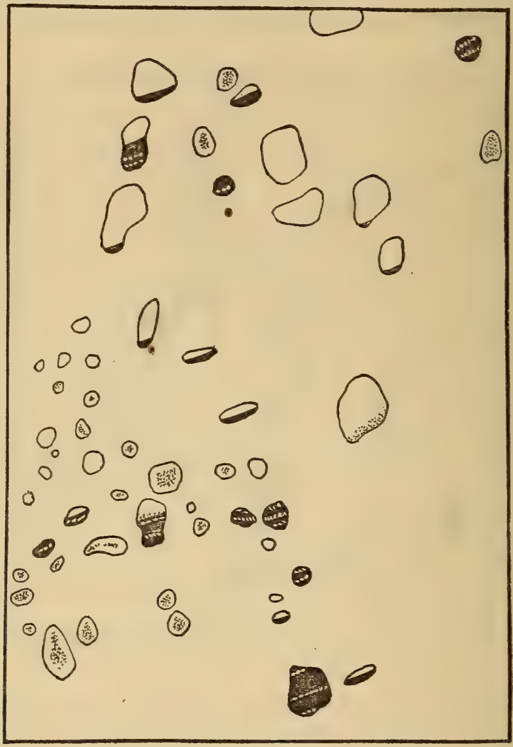
In the Spring of 1877, I first noticed a peculiar structure of the minerals filling the cavities in the amygdaloid rocks of Brighton, which seems to be of value as evidence in regard to their past history, and of interest as not occurring in any other amygdaloids so far as I have learned. While most of the amygdules have a more or less distinctly concentric structure, some among them have an arrangement of colors in parallel bands, dipping rather uniformly about 30°, north; these bands are generally of darker and paler reddish jasper, sometimes occupying all the amygdule, sometimes only the lower part when the structure above is uniform or occasionally concentric. The parallel arrangement of these bands seems to indicate a settling to a level, under the influence of gravity; in other words a stratification in parallel planes which at the time of forming must have been horizontal. There are some exceptions to the regularity of dip of the bands, but the greater number of those I have seen are parallel to each other, and some apparent deviations are due to the amygdules being exposed by a fracture not on the line of dip. They may generally be found in place in a quarry on the west side of Allston St., half way between N. Beacon and Warren Sts., and have been occasionally seen elsewhere in Brighton.

The amygdaloid masses occur between slates and sandstones, which dip 30° a little west of north, so that their strata and the planes of the banded amygdules are closely parallel. Since the bands of the amygdules as well as the strata of the sedimentary rocks must have been horizontal when forming, it must be inferred that the amygdaloid was forced into its position between the stratified rocks above and below, before they were uplifted to their present northern dip. This points to a very remote date for the intrusion of these eruptive rocks, as the enclosing sandy slates were probably tilted early in palaeozoic times. A small piece of evidence of another kind is at hand to confirm this conclusion.

In the field north-west of the corner of Warren and Allston Sts., on a small rocky ledge, is a little opening known to some as the "Briar Patch Quarry." It exposes very clearly a dike twelve to fifteen feet wide, running about north through thin-bedded slates, of which the dip is locally somewhat disturbed. A similar dike cuts the ripple-marked sandstone quarry on Warren St. Without conclusive evidence on the subject, I have considered it probable that these dikes which come up from below, breaking across the slates, are feeders of the amygdaloid masses, which lie at small angles with the strata (v. the preceding paper by E. R. Benton). The sides of the dikes are to be especially noted. They are extremely irregular as if torn apart, and when contrasted with the melaphyr dikes of this district which have comparatively straight sides, imply an eruption before the production of joint-planes in the enclosing slate. As joint-planes are common in horizontal rocks of considerable age, and may be said to occur always in tilted rocks, the evidence of these



feeder-dikes go with that of the banded amygdules, and shows that the amygdaloid took its place among the stratified rocks of Brighton, not only before their upheaval, but at a very early period of their history.



Figures 1 and 2 are taken from drawings made in 1877 from rocks in place in the quarry on Allston St., as seen looking eastward, and so showing the northerly dip. In the first figure, near the middle, two small amygdules are shown, with a less slope in the color line than is usual.

A portrait of the late Dr. Charles Pickering presented by Mrs. Pickering, was shown, and a vote of thanks was passed for the very acceptable gift.

Section of Entomology. February 25, 1880.

Mr. E. P. Austin in the chair. Six persons present.

The following paper was read:—

ON THE PROBOSCIS OF NEMOGNATHA. BY H. HAGEN.

The January number of "Kosmos," p. 302, has a paper by H. Mueller, a Coleopteron with a Lepidopterous proboscis. He states that the complicated proboscis of bees needed a longer space of time for development than the proboscis of the Lepidoptera, which he believes to be developed at once out of the Phryganide mouth-part, because otherwise their relation would not be apparent. He prefers to consider the short proboscis of so many Lepidoptera as aborted, why is not stated. He considers this explanation to be somewhat doubtful, but supported by the transformation of the maxilla of a beetle into a Lepidopterous proboscis, in a comparatively very short space of time. Why this should be a support for his opinion, or why the time should have been very short, is not stated.

Nemognatha chrysomelina of Europe, has the maxilla elongated, but after all only Coleopterous maxillae. A species from Southern Brazil has the maxillae very much elongated, and forming both together a proboscis as in Lepidoptera. Here, he concludes, that in a comparatively short space of time, differentiation in the same genus has produced the same transformation by which the Lepidoptera were separated from the Phryganida.

The fact that Nemognatha has the maxillae elongated, is not a new one, as Illiger, 1807 (Magazin, VI, 333), formed this genus for a similar North American species (*N. vittata* Fab., Syst. Eleut. II, p. 24 = *Zonitis piazata* Web., Observ., p. 60, and *Z. piazata* Fab., Observ., p. 104), because the maxillae are very long and filiform, which fact he indicated by the generic name, Nemognatha.

Dr. LeConte in his Synopsis Melöidum, 1853, divides the species into a group with very elongated maxillae, and a group with maxillae shorter than the body, but nevertheless filiform, as in the others. The fact that these maxillae imitate the proboscis of Lepidoptera is mentioned by Kirby, 1826, II, Letter xxxii, in his Introduction. There are now thirty-two species of Nemognatha described; twenty-six from America; twenty-two from United States; and six from the old world: three from Europe, two from Africa, one from Asia. Now all American species possess more or less long filiform maxillae, while none from the old world do so, though the maxillae are elongated, and one species, *N. rostrata*, is described long ago by Fabricius. I confess I am perfectly at loss to see how or why the twenty-six American species should have been developed in a short space of time out of the old world form, which is not represented at all in America.

When the mouth-parts of the Phryganidae are spoken of in general as short ones, it should not be forgotten that there exist genera with a developed proboscis much longer than the head, and certainly fit to enter flowers; the greatest development I know of among the group occurs in *Plectrotarsus gravenhorstii.*

I believe the whole speculation given in Mr. H. Mueller's paper can not be accepted.

General Meeting. March 3, 1880.

Prof. W. H. Niles in the chair. Nineteen persons present.

The following paper was read:—

THE KAMES OF MAINE. BY GEO. H. STONE.

[Abstract.]

The kames of Maine are so closely related to the surface features of the State, that a brief description of those features necessarily precedes a description of the kames themselves.

GENERAL TOPOGRAPHY OF MAINE.

The surface is disposed in two grand slopes.

1. *The Southern Slope.*

The area of this slope is about 24100 sq. miles; its average width about 140 miles; the elevation above the sea of its northern border, varying from near 2000 feet on the west, to less than 1000 on the east; and its average slope per mile is at least seven feet. This slope is favorably situated for the precipitation of moisture, the annual rainfall being about forty-four inches, and it must have been a region of great precipitation in the glacial period, especially during summer. This would tend to swell the torrents of the melting ice-sheet, and the steepness of the slope would give them great swiftness and power of transportation. The rocks of the southern slope are mainly crystalline, or highly indurated. Although the general slope is southward or south-eastward, yet the map shows that all the longer streams flow eastward or westward for a considerable part of their course, deflections which are usually caused by east and west ranges of hills. The main mountain region crosses the State north-eastwardly in a nearly straight line from the White Mountains, past Mt. Abraham and Mt. Katahdin, to Mars Hill, near the St. John River. South of this are three ranges of hills forming the southern limits of the valleys of the Sandy, the Piscataquis, and the Mattawamkeag Rivers, which ranges are so nearly in a straight line as to make it possible that they really are one system. Still further south is another east and west range of hills, separating the valleys of the Sebasticook and Soudabscook from those of the coast streams, the St. George's, etc. This range reaches from near the Kennebec River to the Penobscot, where it connects with a series of hills extending north and east from Rockland, and the latter may in origin be a part of the irregular system of hills which extends from Mt. Desert north-eastward to the lakes of the upper St. Croix River. It will be convenient to refer to the latter system as the Mt. Desert Highlands. These Highlands consist in considerable part of granite, which outcrops, with some interruption, all the way from Mt. Desert to Chaleur Bay on the Gulf of the St. Lawrence. Much of this granite is coarse and easily fractured, and everywhere the line of outcrop is marked by a great number of granite boulders. This is perhaps more noticeable in New Brunswick than in Maine. Besides those named, numerous other minor ranges, trending eastward or north-eastward, are found, as well as a great number of isolated hills, not, however, of great height.

This arrangement of hills transverse both to the general slope and line of glacial flow must have had an important effect on the movements of the great ice-sheet, particularly during the final melting. When the ice became less than 500 feet thick, over a large part of the State, these long ranges of hills would make further flow of the glacier impossible, unless to the east or west. Long before that the higher ranges must have arrested or deflected the flow, and the extraordinary deflections of the striae in the region north and west of Mt. Ktaadn, may be due to this cause. And it is due to the fact that the streams flow eastward or westward for so large a part of their courses, on account of these transverse ranges of hills, that the kames so commonly do not follow the valleys of the rivers, and thus have escaped erosion. Only a few fragments of the magnificent kame system of Maine, would have remained for our examination, had the kames been subjected to the violence of the rivers in the valley drift period; and no doubt many kames were washed away and re-classified as valley drift, during the rush of waters which characterized that period, as may be seen in the valley of the Kennebec.

2. *The St. John Slope.*

This slope is drained by the St. John River, and numerous tributaries, the largest of which are the Allegash, flowing north, and the Aroostook, flowing east. The grand divide which separates this from the southern slope, is in general quite flat, and in many instances lakes and swamps near the divide have outlets both ways. Over this slope the average fall per mile toward the north and east is from two to three feet. Most of the region may be described as a great monotonous plain, abounding in swamps and varied only by a few peaks and some low rolling highlands. The area of the slope is computed at 7400 square miles, its length 117 miles, its breadth about 90 miles. During the melting of the glacier the action of the waters must have been very different on this gentle slope towards the north and east, from what it was on the steep southern slope.

DISTRIBUTION OF THE KAMES.

In the western part of Maine the most northern kames are those found a few miles north of Kennebago Lake, reported by Mr. Huntington of the N. H. Geol. Survey. On the east the most northern kame is found in Township No. 9, Range 4, west of the East line of the State. A straight line connecting these points passes within a few miles of the northern extremities of such of the intermediate kames as reach farthest towards the north, and is roughly parallel with the coast. North and west of this line there are occasional hillocks, and short ridges or bars of apparently the same origin as the kames, but thus far they cannot be classified into long systems. All who have travelled north of the grand divide speak of the comparative absence of gravel in that region, and even the valley drift is far less in amount than that found in the valleys of the southern streams. The kames proper are a feature of the southern slope, except in the extreme east, where they reach into the valleys of the Aroostook and Medunxnekeag, tributaries of the St. John. It should be noted that the valley of the St. John itself slopes southward in that part of its course.

THE SUPERFICIAL DEPOSITS OF MAINE.

Ever since the publication of the views of Prof. Otto Torell as to the drift of eastern North America (American Journal of Science, Jan. 1877), the writer has regarded the classification proposed by that eminent glacialist as substantially representing the succession of glacial deposits in Maine. This is the same classification adopted by Prof. C. H. Hitchcock, and by Mr. Warren Upham, of the N. H. Geol. Survey, and like them the writer for the most part employs the Scotch names. The following list of glacial and post-glacial deposits observed by the writer in Maine, is appended as an explanation of the terms employed in the descriptions that follow. Beginning with the lowest, the order of succession of the superficial deposits is as follows:

1°. THE LOWER TILL, supposed to be the ground moraine of the continental glacier. A tough, stony clay, commonly called hardpan, with intercalated masses more sandy or gravelly in composition; color grayish or bluish, boulders usually small and for the most part glaciated. This formation appears to consist of the pre-glacial soil, together with such of the underlying rock as could be broken and planed off by the glacier. Generally the weathered parts of the rocks were thus planed off but not always. At Brownville, where the laminae of slate are nearly vertical, the lower till filled up the spaces between ragged tooth-like projections of the weathered slate, and the glacier flowed in over the whole, in some cases not breaking even thin plates which project two inches or more, and are without any backing whatever except the compacted till. At Russell Mountain in Blanchard, high granite cliffs facing the south are deeply fractured into blocks which have been weathered and rounded in situ, into typical granite boulders, a portion of which were partially displaced by the glacier from their native bed. Although much of the material of the lower till has come from a distance, yet in our extensive areas of slate this formation is usually finer and more argillaceous than in regions of crystalline rocks. In Maine where granitic and schistose rocks abound, aggregations of lower till commonly take the lenticular type, or that of the broad rounded ridge, while in areas of slate, and fossiliferous rocks which are but little indurated, there is also a decided tendency to form narrower ridges, which sometimes have so steep sides as to be mistaken for kames. As a rule they are nearly parallel with the line of glaciation. In N. Berwick the lower till is composed of two well defined layers. The lower is excessively hard and blue, and composed almost wholly of granitic fragments like the underlying rock. The upper layer is partly composed of the local granite, but chiefly of micaceous slates, such as are to be found to the northward. These ferruginous slates give a browner color to this layer, and it is not so compact as the lower. At Portland there are vertical pockets of sand in the ground moraine.

2. *The Upper Till,* supposed to consist of the morainal detritus which was *in* the ice, and above the land surface. This formation is looser in structure than the ground moraine, in fact it is much like a modern moraine. Its color is browner, and its boulders larger, while few are distinctly glaciated except in lee of a high, precipitous peak. Intercalated masses of clay, sand, or gravel, are common. Accumulations of upper till are very variable in form and distribution.

3. *The Kames or Eskers,* including that part of the till which was classified by water and was deposited upon the ice or within ice walls. No distinction of names is made between the longer and the shorter systems. The systems here described are, however, homologues of the. Scandinavian aasar, rather than the short ridges (= kames) to be found near the terminal moraine.

4. *The Valley Drift,* including all that part of the modified drift which was deposited after the ice had melted at the place of deposition. In valleys of moderate slope the lower layers are usually of fine sand or clay, the upper of coarse sand or gravel.

5. *The Lower Marine Clays.* These are fine, generally dark or bluish, often fossiliferous, especially in the lowest layers. They alternate with fine quicksands and contain occasional stones and boulders.

6. *The Upper Marine Clays.* These are for the most part browner or grayer than the lower clays, and few fossils have yet been found in them. They are in Maine commonly called clay-loam, and are often quite sandy in composition. They contain numerous stones and boulders, particularly the upper layers. In fact the surface is in some places so overwhelmed with boulders that the formation closely resembles glacial till. Such formations are, however, quite local. On low levels the layers of the clay may be seen to come up to the sides of large boulders without distortion, showing that part of the clay was deposited after the boulder, also that the boulder dropped from above quietly. On the higher levels the distribution of these boulders overlying sedimentary clay, is different from that of glacial boulders, as they are massed on the northern slopes of hills, or in other places favorable for the stranding of ice floes. The transportation of boulders by floes of shore ice from the ice foot may be seen almost every winter in the Penobscot and Passamaquoddy Bays. A smooth beach on the latter bay was not long since almost buried out of sight under the boulders brought there in a single season by stranded ice floes. The fossils found in our Champlain clays long ago showed that they were deposited in an icy sea, and this has been recently emphasized by the finding of a walrus skeleton at Portland, near the line between the upper and lower clays. Transportation by floes and small bergs must have been more rapid in such a sea than it is at present, and may account for the erratics and what resembles till overlying the marine clays. In short, the writer as yet cannot find evidence of a general re-advance of the glacier after the deposition of the marine clays. The lower or fossiliferous clay is of Champlain age, and appears to correspond to the Leda clay of the Canadian naturalists. The upper or non-fossiliferous clay is in some respects the analogue of the Loess. It graduates by degrees into the under clay of the valley drift, or perhaps into the upper portion of that clay. Yet it is found over all, or nearly all that part of the State where are the fossiliferous marine clays, which shows that it cannot be wholly a fresh water or estuarine formation. Its horizontal transition into the clay of the valley drift, shows that a general re-advance of the glacier ought to cover the latter clay with till, but this has not yet been observed.

7. Depositions by streams and the sea, during the recent, or terrace epoch.

GENERAL DESCRIPTION OF THE KAME SYSTEMS OF MAINE.

For convenience these systems are numbered, beginning on the east. Several of them branch like rivers, and all kames supposed to be connected are here classified as a single system, the longest tributary being regarded as the main kame and the others as branches, and all are numbered accordingly. The first letters of the alphabet, *a*, *b*, etc., are annexed to the system number to designate branches plainly connected with the main kame; *m*, *n*, etc., to designate probable branches; *x*, *y*, etc., to designate kames whose connections are decidedly in doubt, but cannot yet be proved to be distinct from the system to which they are thus provisionally annexed. The use of the middle and last letters to indicate degrees of doubt as to the connections of kames has been found necessary, partly because they are not fully explored, and partly because of the gaps which are almost always found in the kames on steep down slopes, or in valleys where the streams have often washed them away in great part, or in regions which were under the sea in the Champlain period, where since deposition, the kames have often been wholly or in part re-classified, or covered out of sight by marine deposits.

These systems have been mapped in greater part from my own observations, which have been made at intervals during the last four years. An instrumental survey of so great a field was out of the question, and hence my method has been by a reconnoissance to locate the kames by reference to such features as will be sure to be shown on an accurate map of the State, when one is made. It is believed that on the scale of a small map, this will show the topographical relations of the kames with sufficient accuracy. Where kames have been mapped from the reports of others, it has only been after careful tests of their accuracy, and after being confirmed by the testimony of several.

I. St. Croix River System.

Not yet fully explored. It is said to originate in New Brunswick in the valley of Palfrey Brook. It crosses Chiputneticook Lake, and follows the valley of the St. Croix River to the mouth of King Brook, and perhaps to Chiputneticook Falls, and probably connects with the kame which reaches along the lower Moannes valley to Baring, Charlotte and Pembroke. Near the mouth of Canoose River, this kame sends off two series of kame-plains south-easterly, one on each side of Basswood Ridge, each about five miles long. Possibly the gravels along Goat Brook and the west branch of the Didgequash River, are a connection of this system.

Length from Palfrey Brook to Pembroke, about 60 miles.

I a. A small kame joins the main one at Vanceboro, thus far traced for one and a half miles, but probably with northern connections.

II. Houlton—Meddybemps System.

This system begins in Twp. No. 9, R. 4, Aroostook County, as a ridge running for two or three miles nearly parallel with the Blackwater (or Alegwanus) River, which stream runs north-westerly into the Aroostook River. The ranges of hills which reach westward from Mars Hill, are here reduced to a few peaks and swells overlooking a broad plain which forms the lowest depression in this chain to be found in that region. The ridge at this place is composed of gravel but little water worn, and the quartz and other hard fragments are quite angular. Interspersed in the gravel is a fine fertile soil to a considerable depth. This may show that sluggish currents classified the gravel, or that the finer clay, etc., have been the result of the weathering of the soft fossiliferous fragments here abundantly found in the kame. From here, with a number of short gaps, the kame makes its way south-easterly over a rolling plain, to the northwest corner of Littleton, and thence southerly to Houlton. There is no continuous valley along this route, and the kame several times passes from the valley of one stream to that of another, but it does not cross any hills more than 100 or 200 feet high, measured on the north side. At Houlton the gravel is much more water-worn than it is further north, and contains much material from the crystalline region near its source. It is here a prominent ridge, pell-mell in structure or obscurely stratified at the exposures examined, and it plainly meanders like a river. It next runs south along a branch of the Medunxnekeag River, through Hodgdon, and then soon crosses obliquely to the east of the Houlton-Calais road, its course lying along a low valley, nearly parallel with that road for several miles. In this part of its course it is much broken, and often consists of a line of occasional gravel swells. Near the north line of Orient this kame joins II a, and for several miles south of the junction the kame is quite a large ridge, upon which the Calais road runs. In Orient it runs into the upper end of Grand Lake, and the evidence is conclusive that it extends along and under this lake. The lumbermen in warping logs down the lake frequently strike it with their anchors.

It appears in several places along the shore, running as gently sloping points far out into the lake, and it emerges as "horseback" islands. At the south end of the so-called "Arm of Grand Lake," it forms a moderate sized ridge of coarse sand or very fine gravel, plainly stratified, the strata dipping 35° lengthwise of the kame, which is here running south-easterly into a remarkable pass through the high ranges which form the continuation of the Mt. Desert Highlands. One fourth of a mile south of the arm of the lake, in the jaws of this pass, the kame disappears from the surface, and is buried out of sight by a mass of boulders and other coarse glacial debris. I could not discover evidences of an ordinary land-slide, nor of a channel cut in the lower till. More probably these boulders tumbled into the channel of the kame-stream from the ice at the sides. The shrewd builders of a road through this wilderness found this underlying gravel, and their excavations revealed the above stated facts. The stratification of the kame at this point shows that a kame river certainly flowed south-eastward through this Spruce Mountain pass, and over a low divide, not more than thirty or fifty feet higher than Grand Lake. To the south of this divide no gravel can be found for several miles along a slope of about twenty feet per mile.

It would be interesting to know how far south of the lake the kame continues covered out of sight by the upper till. The fineness of the gravel in the pass shows that the current might be expected to sweep all sediment from its channel when once it began to flow down the steeper slopes to the south, providing the slope of the land had any effect on the flow of water. From Grand Lake there are two lines of valleys favorable for the flow of a kame-stream, one south-eastward via Scott's Brook to the St. Croix River, and the other down the valley of Tomah Stream. The stream seems to have taken the latter course. After a gap of about five miles the kame begins again not far south of Tomah Station on the European and North American railway, and soon expands into extensive sand and gravel plains, that is, systems of reticulated ridges. These extend to near the mouth of Little Tomah Stream, where a single ridge begins and continues south along the west side of Tomah Stream. It crosses the Schoodic River into Baileyville, and thence goes by a low pass in Alexander (where it is much broken), to Meddybemps Lake, where it expands into quite a large sand and gravel plain. This must have been the terminus of the kame stream, during some part of the kame period, but a line of occasional gravels shows that at one time the stream ran southward through Dennysville and Edmunds, and crossed Trescott to the sea.

Length of system about 150 miles.

II a. New Limerick—Amity Kame.

Length about twenty miles from near the centre of the town of New Limerick, in nearly a straight general course to join the main kame near the south line of Amity. In Linneus is a prominent ridge, very meandering by short zigzags.

II b. Weston Kame.

A local kame running for two or three miles to join the main kame in Grand Lake.

II c. Island Falls—Danforth Kame.

Extends from near the north-east corner of Hersey through Island Falls to Haynesville. It here leaves the valley of the Mattawamkeag and crosses a low col, keeping for part of the way along the side of a hill, and about half way up the slope. It continues nearly south till within three miles of Danforth, when it turns south-eastward by a beautiful curve whose chord is about one mile in length, and thence points straight toward the Danforth pass. South of Danforth there were two passes, the more favorable one leading directly south to Baskahegan Lake; but the kame took a higher and narrower pass south-eastward along the line of the E. and N. A. R., and joins the main kame a short distance south of Tomah Station. At Danforth and northward the kame consists of fine gravel, while at Forest Station near the col it is almost wholly of pebbles. East of Forest it disappears for about three miles on a down slope of thirty feet per mile. Length 55 miles.

II d. Little Tomah Stream Gravels.

Length about six miles from Little Tomah Lake to Tomah Stream. Partly of kame origin.

III. East Machias System.

Not personally explored. A series of gravel ridges running for near four miles northward from East Machias and nearly parallel to the road to Cooper.

III m. Crawford Kame.

A kame about one mile long is found near where the Air Line road from Calais to Bangor crosses the East Machias River. Probably a kame-stream ran down this valley, but if so its gravels have been disguised by the sea in the Champlain period.

IV. Musquash Stream System.

This extends about seventeen miles, from near Musquash Lake in Topsfield, to Big Lake, and perhaps beyond. If it ends at Big Lake, it is one of the very few kames of its length, which do not end at the south in " plains."

V. Grand Lake — Old Stream System.

Grand Lake is a beautiful body of water bordered by high ranges and peaks, being situated in the heart of the Mt. Desert Highlands. It is often called Western or Schoodic Grand Lake, to distinguish it from the Eastern Grand Lake, situate on the upper St. Croix. A kame comes down the eastern arm of the lake to the outlet, thence southerly to the valley of Little River, thence down the valley of Old Stream, for much of the way as kame-plains. Length, about 25 miles.

V a. Farm Cove Kame.

Length about eight miles from Farm Cove on Grand Lake, southward through a low pass to join the main kame in the valley of Little River.

V b. Length about sixteen miles along Chain Lake Stream, and Clifford Stream, and perhaps northward to Big Lake.

Note. Probably systems IV and V are one system, but thus far I cannot prove the connection. Much of this wilderness is swampy and very difficult to explore.

VI. Baskahegan Lake — Machias River System.

Length about forty-seven miles, from near the north-west angle of Baskahegan Lake, through a low pass in Kossuth, thence through Pleasant, Scraggly and Junior Lakes, and then along the west sides of Grand and Pocumpus Lakes. It then expands into plains reaching toward Waubausoos Lake, also to Machias 3d Lake, and thence along the Machias River to near the Calais-Bangor air-line road. An extensive system, measured by the amount of sand and gravel it contains, and of very gentle slope.

VI x and y. Bancroft and Hot Brook Kames.

A kame crosses the E. and N. A. Railway, about one mile west of Bancroft Station, northern connections unknown. Southward probably connects via Hawkins Brook with a kame found for about five miles along Hot Brook, and which may connect with VI. A large sand and gravel plain found near upper Hot Brook Lake, may have been formed by either a stream running south from Bancroft, or northward along Hot Brook. The only point of special interest is that here a kame-stream may possibly have flowed northward.

VI m. Length about five miles, from near Springfield village to Junior Lake, and perhaps then connecting with the main kame. Runs down a steep slope and is very interrupted.

VII. Sisladobsis — Pleasant River System.

A partially explored system through a dense wilderness where the existing maps are at best only caricatures. Length about 40 miles.

VIII. Seboois — Springfield — Deblois System.

So far as now known this system begins north of Seboois 2d Lake in Township No. 7, R. 7. It crosses this lake and follows along the west side of the east branch of the Seboois Stream till it reaches the road to Seboois Farm. There in front of it toward the south is the wild gorge by which the Seboois Stream makes its way to the sea. Instead of taking that valley by what are now the easiest slopes, it here turns easterly along the valley of Hay Brook, and, after crossing a low col, it follows Hot Brook to the Upper Shin Pond. Here again the natural valley of drainage leads south, but the kame keeps on southeasterly across this valley and makes its way through a low pass in the Mt. Chase range of hills, and thence follows the valley of Peasley Brook southerly to its junction with Fish Stream, about one mile west of Patten village. Here again in front of it is a low open valley reaching for several miles toward the south, then ending in high hills. The kame turns by an abrupt curve a full right angle toward the east and follows the valley of Fish Stream for nearly four miles, being almost wholly washed away just at Patten village. Fish Stream runs eastward into the Mattawamkeag near Island Falls, but the kame leaves this valley, turns a right angle very abruptly towards the south, and finds an outlet by a low pass down the valley of the Molunkus River. In fact it finds a much lower pass by this route through Golden Ridge and Sherman than if it had run on straight south from the mouth of Peasley Brook, just the kind of anticipatory choice of passes which water could be expected to make. In this part of its course the kame consists for the most part of slate. Along the Molunkus the kame is badly washed away and is very interrupted. In Kingman the kame crosses the Mattawamkeag valley and then runs up that of the Mattagoodus which flows north. It is here a well developed ridge, becoming coarser and more interrupted as we approach the divide in Springfield. In Springfield the kame-stream rejected a low pass south-eastward and chose a lower pass south-westward to No. 3 Pond, south of Lee, thence southeasterly to the Passadumkeag River, which it crosses, and then abruptly turning south-westerly, it follows near this river for several miles. After crossing Nicatowas Stream it turns more nearly south and soon south-easterly, and thence follows the valley of the Narraguagus River, ending in the great Deblois plains. Not far north of Beddington the main kame consists almost wholly of large pebbles, from one to three feet in diameter—a great windrow of them. For many miles along the Narraguagus the kame-stream threw off plains toward the west in all low places, sometimes for one or more miles, while toward the east, where is the river, plains are seldom found and then only in a narrow belt. In other words, on the side where is the lowest ground we have the fewest plains. These kame-plains consist of a multitude of ridges, connected by cross-ridges. Both north and south of Lead Mountain, broad lobes of these plains were sent off to the west at right angles to the main kame which skirts the eastern base of the mountain. The remarkable features of this kame are its length, the vastness of the deposits along its lower course, the number of times it leaves one valley and passes into another, its refusal to follow valleys which would give, judging by the land surface, better slopes than by the route of the kame or vice versa, its anticipatory choice of passes which for a time give less favorable slopes but in the end more favorable, also the fact everywhere observed that the kame is usually larger on a level or up slope, while in narrow passes or near the height of a divide, or on down slopes, it is smaller, of coarser material and often disappears for short distances ; and then perhaps should be added, the fewness of its branches. Its windings are usually determined by valleys or low passes ; in the level Nicatowas region the kame-stream had a chance to zigzag at its own sweet will free from the tyranny of hills, and it meanders nearly as much there as elsewhere.

Length of system, about 130 miles.

VIII a. Mattakeunk Kames.

Length about ten miles along the Mattakeunk Stream through Lee village to No. 3 Pond, where they join the main kame. Local gravels are reported along Gordon's Brook and the Mattawamkeag below the mouth of that stream but are not yet proved to be kames.

VIII m. Union River Kames.

These extend from near Nicatowas Lake southwesterly down the west branch of Union River, ending in the Aurora plains, where this kame-stream has washed away system IX, showing that this series of gravels was deposited in the last of the kame period. This series is provisionally marked as a part of system VIII, and if correctly, then we have a kame-system branching like a river at its delta. The country is wild and not personally explored by me, but I have statements from a number of observers which show that system VIII connects down this way.

Length about 17 miles.

IX. Seboois — Enfield — Deblois System.

This system appears to begin in No. 7, R. 7, within a few miles of the source of system VIII. It passes Seboois farm, its course being parellel to the west branch of the Seboois Stream. It ends, so far as can yet be made out, right in front of the gorge by which Seboois Stream makes its way through the Katahdin Highlands. In the gorge it has been wholly washed away and re-classified for most of the way for twenty or twenty-five miles, which is not surprising when we consider the narrowness of the valley and the vast currents of which we see the signs as having swept down the defile during the valley drift period. Where the valley widens the kame begins and continues fourteen miles to Medway, where it crosses the main Penobscot River and turns easterly for about two miles. Here the open Penobscot valley lay right before it, but it makes an abrupt bend through a total deflection angle of nearly 135° and runs southwest along the valley of the Pattagumpus. It then follows the Maddunkeunk to Chester, turns south-westerly and soon more easterly, crosses the Penobscot again at South Lincoln (Hockamoc Island) and thence continues through Enfield, Passadumkeag, Greenbush, Greenfield, and so on to Aurora and Deblois.

The principal features of this kame are the following. In Passadumkeag and Greenbush it has been under the sea and well illustrates the action of the marine waves and currents in modifying the kames. In Greenbush it is in three places piled up into a kind of plain from 40 to 120 feet higher than the rest of the kame. These are locally known as "mountains" or "pinnacles," and are a remarkable feature of the landscape, being found in the midst of a great clay plain. In Greenfield the Katahdin kame unites with this one near the shore line of the Champlain sea and both seem to have thrown out plains (probably during the very last of the kame period) and then the sea has curiously washed and re-classified them. Bars, swells, flats, plains—the whole country is unique and has an indefinable lack of character for a kame country. The flanks of the pinnacles above mentioned are strewn with boulders, the work of ice-flows, in my opinion. At the col dividing Union from Sunkhaze waters the coarse moutonned slates are swept clean of everything except large boulders. Seldom in Maine does the lower till appear to have been eroded by the kame-streams, but here everything has that appearance. The rocks are more bare on the line of the kame than elsewhere, but the region is so wild and the distribution of the till so irregular, that this may be only a freak of the till. A little to the east of this place the kame consists of a ridge of coarse slates and granite, otherwise for seven miles after entering the granitic region of the Mt. Desert Highlands the kame is almost wholly composed of slate, although the fields on either side are full of granite. The kame to the north of this point has passed through a region of slate. In Aurora this kame forms a magnificent double ridge fully one hundred feet high, called the Whales-back.

Length of the system about 130 miles.

It will be noticed that Systems VII, VIII and IX all end in a great series of plains probably containing about two hundred square miles. I have called them the Deblois plains, from the name of the town in their centre. It was on these plains that the base line of the U. S. Coast Survey was measured. Within these plains are local plains of sedimentary clay, which may possibly point to local lakes during the kame period when the kames with their underlying ice might have enclosed a temporary lake.

IX a. Staceyville — Salmon Stream Kame.

Length about twenty miles from the south part of Staceyville, to join the main kame at the mouth of the Pattagumpus.

IX aa. Salmon Stream Kame.

A kame extends from near Salmon Stream Lake to join the last named kame not far from the Penobscot river.

IX x. Mattakeunk Kame.

A kame two or three miles long is found along the Mattakeunk stream, reaching from the Penobscot north.

IX m. Sam Ayer's Stream Kame.

Length six or more miles along Sam Ayer's Stream, above its junction with the Mattamiscontis.

IX b. Katahdin Kame.

This probably begins near the west branch of the Penobscot at the mouth of Katahdin Stream. It then runs nearly east along Aybol Stream, and sometimes north-east, for about twenty miles to Millinocket Lake, thence south along Millinocket Stream, up the Nollesemic Stream, through a low and narrow pass, and then down the Seboois Stream to Howland, thence to Argyle where it crosses the Penobscot at Olamon Island, and thence takes a straight course to join the main kame in Greenfield. The chief feature of this kame is its east and west course at its upper extremity, and its crossing the Penobscot valley two or three times. Length about 70 miles.

IX bx. A possible branch of the Katahdin kame found along Soper Brook, north of Ripogenus Lake, in Twp. No. 4 R. 11. Length two miles.

X. Clifton — Hancock System.

A small kame, but instructive as being a fair type of the way the kames penetrate the high mountain ranges. It begins near Clifton P. O., runs for a short distance southward, then curves nearly eastward, and shoots straight into a low pass in the Mt. Desert Highlands. This pass is 180 feet by aneroid, above Clifton P. O. After crossing the col it follows a valley southward into Otis, and probably beyond. Length about 20 miles. There is another kame in Clifton, found two miles or more north-east of this one, and which may be a branch.

XI. Moosehead Lake — Penobscot Bay System.

Extends from Sand Bar and Hogback Islands in Moosehead Lake, south through a low pass in Shirley, then disappears for a few miles in Blanchard on a down slope of forty-five feet per mile. It reappears at Upper Abbot, and follows the Piscataquis valley to Sangerville, and then along the valley of Black Brook, past Dover South Mills, to the "Notch" in Garland, a remarkable pass through the range of hills which borders the valley of the Piscataquis on the south. A little south of the Notch it disappears for about a mile, then re-appears and continues south-easterly past East Corinth to near the north line of Levant where it turns south to Hermon Pond and thence through W. Hampden to Ball Hill Cove on the Penobscot, then along the west side of the river (past Frankfort in the river), and through Stockton and Prospect into Penobscot Bay, near Fort Point. This system has no reticulated kame-plains of considerable size. Three miles north of Hermon Pond it forms a broad solid ridge or plain, and just south of the Notch it has thrown out a parallel ridge or terrace. At Greenville and Dover South Mills, where it is on an up slope, it is a well-developed ridge. From the Notch south it has been under the sea and has been greatly modified by the waves and currents, and for most of the way has been wholly or in part covered by marine sands or clays. Length about 105 miles.

XI a. South Twin Lake — Winterport Kame.

Extends from S. Twin Lake south to Seboois Lake, through and under this long lake, showing at the surface as a series of "horseback islands," thence via Medford to Lagrange, then along the line of the Piscataquis R. R. to Pea Cove, thence along the west bank of the Penobscot through Orono and Bangor, to join the main kame at Ball Hill Cove, in Winterport. Has been in part washed away by the Penobscot. The marine clays near this kame often contain large numbers of gravel stones and pebbles washed down from the neighboring kame. A well developed kame, without large kame-plains.

XI aa. Schoodic Stream gravels.

An interrupted series reported along Schoodic Stream and Lake, partly kames. Length probably 8 miles.

XI a m. Jo Mary Kame.

A kame is reported along Pratt Brook, a stream which runs nearly east into Middle Jo Mary Lake. This kame runs nearly east and west, and probably connects with XI a near S. Twin Lake. Length about 10 miles.

XI a b. Charleston — Hampden Kame.

Extends from near the south line of Charleston, east of the east ridge in Corinth to Kenduskeag village, thence south-westerly to Levant village, then southward over a low col and through Hermon Bog to join the main kame near Hampden Upper Corner. Length 26 miles. Has no large kame plains, either solid or reticulated.

XI b. Exeter Mills — Hermon Pond Kame.

Extends from near Exeter Mills in nearly direct line through West Levant to join the main kame near Hermon Pond Station. Has been under the sea for a large part of its course, and its meanderings have been rendered beautifully regular by the sea, and rounded bars have been left at the salient angles. Length 15 miles.

XII. Roach River — Pleasant River System.

A kame extends nearly east and west along the Roach River Ponds, and by a low pass into the valley of Pleasant River. This valley slopes very steeply, and no kame appears in it except for about three miles below the Lower Ebeeme Pond, and below

Brownville. This kame possibly joins XI a in Medford, but is provisionally marked as a distinct system.

XII m. Katahdin Iron Works Kame.

About five miles long; situated in the valley of the west branch of Pleasant River, above Katahdin Iron Works. Probably this also is a branch of XI a. Yet there are a few signs that the ice lingered in these mountains longer than on the lowlands, and hence these may be of later origin than XI a.

XIII. Lilly Bay — Sebec System.

This system leaves Moosehead Lake at Lilly Bay and finds its way by a crooked route along low passes to the valley of Wilson Stream, which it follows to Sebec Lake, or beyond. This also may be a tributary of X a. Length at least 25 miles.

XIV. Corinna — Dixmont System.

This system crosses the Maine Central R. R. at East Newport. It ends at the south in a sand and gravel plain in Dixmont. This kame crosses two transverse ranges of hills seventy-five and one huhdred feet high, respectively. Near the top of the hills the kame is stratified but nearly disappears. In the valley between the hills it is larger but seems to be pell-mell in its structure, at least where exposed. North of Plymouth this kame goes over a hill seventy-five feet high, when a very little deflection to one side would have taken the kame-stream through a low valley where there would be no hill to cross. Length 20 miles.

XIV x. There are a few short gravel ridges in Troy and the western part of Dixmont which may belong to system XIV.

XV. Hartland — Searsmont System.

This kame begins near Hartland village, and extends quite continuously through Palmyra and Pittsfield to Unity. It is everywhere bordered and in part covered by marine sands and clays. Although passing through a level region it shows many abrupt meanderings. From Unity southward to near Thorndike Station, there are only a few exposures of gravel along the valley of Sandy Stream. This valley is deeply covered with sands and clays, partly of marine deposition, and probably in part deposited by the stream itself. This was near the shore line of the Champlain sea, where tidal currents would sweep back and forth with great violence. Near Thorndike Station the kame rises out of this valley and extends southward along the side of the hills which border the valley of Half Moon Stream on the west. In Knox this valley turns southwesterly, while the kame keeps straight on south across it, and then ends on the northern slopes of a high range of hills. Here is a gap of about three miles where there are only a few small gravel beds, and then a number of large ridges begin near the north side of the valley. They cross it obliquely, and run southward through a low pass which skirts the western base of Hogback Mountain in the northern part of Montville. They thence continue down the valley of a branch of the St. George's River, and end in a large sand and gravel plain near the north line of Searsmont. A few small ridges are found below here, and perhaps this kame-stream once flowed to the sea, but if so the gravels are now disguised by Champlain clays. Length of system about 40 miles.

XVI. Montville — Liberty System.

A local system ending at the south near True's Pond in Liberty. Length about 5 miles.

Note. The coast region lying between the Kennebec River and Penobscot Bay contains less gravel than any other region of its size in Maine, situated within one hundred miles of the coast.

This is caused by the high hills to the north which formed a barrier to the escaping waters except in Albion and Montville, and there the gravels do not seem to have reached to the sea as they do farther to the east or west, at places where there are low passes lying to the north.

XVII. China — Alna System.

Extends from the northern part of China through and along China Lake past South China, and then in nearly a straight line through the villages of North Windsor and Windsor to the Sheepscot River in Whitefield and thence into Alna where in the form of sand plains it ends, unless a short kame in Georgetown be a connection. Through Windsor the ridge is from one-fourth to three-fourths of a mile wide and near one hundred feet high, with three or four gaps of near one mile each. These flat-topped ridges or solid plains form a remarkable feature of the landscape, and contain but few funnels. In one place a short high ridge is covered with angular erratics and a mass resembling till in structure, and local deposits of the same kind abound. Length 32 miles.

XVII a. Albion — Whitefield Kames.

This series begins about two miles north-east of Puddledock in Albion as a terrace from one-eighth to half a mile wide and rising about seventy-five feet in height above the flood plain of 15-Mile Stream. To the northward lies a plain deeply covered by marine clays; at one time I mistook this terrace for a beach of the Champlain sea. Further exploration shows that it ends abruptly on the north and east and that there is nothing like it for several miles in that direction, hence it cannot be a beach. The surface layers of this plain or terrace contain many large pebbles while below there is for the most part fine sand or gravel. About two and a half miles southward from its source there is a short break in the system and the kame then reappears not as a terrace along the side of the high hill but as a ridge in the midst of the valley. This valley is narrow and bordered by frequent hummocks and ridges resembling lateral moraines. During the Champlain period it was probably a strait connecting the Sebasticook bay with the open sea and if so would be swept by powerful tidal currents. The kame crosses a low col and extends in nearly a straight line to the Sheepscot river near Week's Mills, where it expands into broad sand and gravel plains partly overlain by the non-fossiliferous marine clays. From here an interrupted series of gravels extends down the Sheepscot to join the main kame in Whitefield.

Length 20 miles.

XVIII. Eastern Kennebec Valley System.

A series of kames begins abruptly at Somerset Mills, and is a well defined system as far south as the head of Swan Island. Its course lies near the Kennebec River, which it several times crosses. In Fairfield, Waterville and Gardiner it is for the most part on the western side of the river, in Vassalboro and Dresden on the eastern, while in Augusta and Hallowell it expanded into a series of parallel and interrupted ridges, a part of which lie on each side of the river. South of Dresden the system is represented by only a few occasional ridges which thus far have been traced to Abagadassett Point in Merrymeeting Bay. Probably the course of the system here followed the river, and the gravels have been in great part washed away. Many sections along the course of the kame show marine sands and clays overlying the kame.

Length 50 miles.

XVIII m. Canaan — Clinton Kame.

Nowhere a large ridge. Is quite discontinuous north of Canaan, and south-west of Clinton, where it seems to have been almost wholly washed away by the Sebasticook river. It probably joined XVIII at Winslow. North of Clinton this series well displays the action of the sea upon the Kames. Length 15 miles.

XVIII x. Mayfield — Brighton Kames.

A broken series of short kames is found in the western part of Blanchard, and extends through Mayfield into Brighton. The connection would be easy between here and XVIII at Somerset Mills by the valleys of the Wesserrunsett and Kennebec, but thus far the connection cannot with certainty be traced.

Length 8 miles.

XIX. Upper Kennebec Valley System.

We have here well displayed the destructive effects of the streams of the valley-drift period upon the kames. A series of gravel ridges is found along the Kennebec Valley from near the Forks to Embden. Most of these are ridges of erosion, that is, portions of the old flood plain, the river having cut deep channels, first on one side and then on the other of these ridges. Generally the abandoned channels are partly filled up, but there are a number of places where the old channel is still of its original depth, and here will be found a lakelet. Sections displayed where the river meanders from one side of the valley toward the other show that there is a belt of gravel and pebbles along the axis of the valley bordered on both sides by finer sediments. The abruptness of the transition from the coarser to the finer deposits, which is seen in some places, makes it probable that these central ridges are formed from the gravel of a kame, which was for the greater part re-classified by the river during the Valley Drift period; at least that there was a kame toward the north. Toward the south the sections are not conclusive. I doubtfully mark this central belt of gravel as re-classified kame as far south as Embden, a distance of about 35 miles.

XIX m. Parlin Pond Kame.

A kame nearly one mile in length. May have been deposited by currents flowing either north or south.

XIX n. Kibby Stream Kame.

Length about four miles along Kibby Stream, a tributary of Spencer Stream. The latter flows into Dead River near Grand Falls.

XIX o. Dead River — Jerusalem Kame.

Extends along a low pass southwards from the great bend of the Dead River and past the eastern base of Mt. Bigelow. It disappears near the divide between Dead River and Carrabasset waters, but the extensive plains of sand and gravel found in the valley of the latter stream above Kingfield were probably in part a continuation of this system. But here, as well as at the great plains about North New

Portland, and in numerous other valleys in the mountains, the original kames have been largely washed away and re-classified as valley drift. The latest explorations of the writer point toward the classication of the kames here included with system XIX as distinct kames rather than as branches of one system, as they are here provisionally classified. Length, 5 miles.

XIX p. Stratton Brook Kame.

Extends for about three miles along Stratton Brook, four miles from Eustis, and near the road from Eustis to Kingsfield. From it a low pass reaches south-eastward; so that it is probable that the streams which deposited XIXn, XIXo, and XIXp united in the valley of the Carrabassett.

XIX p x. A kame three miles long is reported near the divide between Arnold River, a tributary of the Chaudiere, and the Dead River above Chain Lakes.

XIX q. Anson — Madison Kame.

Extends from near the Carrabassett River in the western part of Anson south and easterly through a low pass to the Kennebec River. As kame-plains, it crosses into Madison not far from the mouth of Sandy River.

Length about 10 miles.

XIX r. Norridgewock — Sidney Kame.

Extends from near Norridgewock through Smithfield and Belgrade, ending in a plexus of ridges at Sidney Plains, or possibly connecting with a short kame in Manchester. Length 20 miles.

XIX r a. Kame in Smithfield two miles long.

XIX r b. Mercer — Belgrade Kame.

Length about eight miles from Belgrade Great Pond, where it joins XIXr, to within two miles of Mercer village. Follows a low pass along the east base of Hampshire Hill.

The above mentioned branches of system XIX are connected by continuous lines of low valleys, and hence would naturally belong to the same system, if formed contemporaneously. Further investigations may show that they are distinct kames, and they are only provisionally marked as parts of one system.

XX. Chesterville — Leeds System.

Extends from near Chesterville Mills, through a low pass at Twelve Corners, and thence through East Livermore into Leeds, where it spreads into extensive plains. For all this distance it is bordered and in part covered by non-fossiliferous clays or sands. A ridge about one-half a mile south-west of Leeds Junction appears to belong to this system. Along Sabattus Lake the gravels, if they are there, are covered by the clays. Near the south end of Sabattus Lake a large ridge begins quite suddenly and within a mile expands into a plain three-fourths of a mile in diameter, flat topped, and a solid mass of sand and gravel, except near one edge where are a few funnels and lakelets. This plain is bordered by high, steep slopes on all sides, or would be but for the clays which plainly overlie the gravels, and in some places come to near the top of the plain. Then after a break of two or three miles there is another arge ridge perhaps one mile in length. Then comes another break of one-half a mile in the series, and then a high and broad ridge about one-half a mile long, and 116 feet by aneroid above the surrounding clay, and as the clay is quite deep in the vicinity, the ridge is probably 140 feet above the till. This ridge is situated near Lisbon village. From here kame gravels are found at intervals along the Androscoggin River, as far east as the mouth of Little River, where the river system is re-inforced by a local system which has come down the Little River valley from the direction of Litchfield. The sand plains of Brunswick and vicinity are of marine deposition, though the material may have originally been brought down by this kame-stream. In view of the long break in the system south of Leeds Junction, I provisionally mark the main kame as reaching to Leeds, and the series of ridges found along the Sabattus and Androscoggin valleys as a probable continuation. The size of this system in Chesterville demands a large supply of water, and probably a kame-stream ran down the Sandy River valley. If so, its gravels have been almost wholly re-classified into valley drift by the river, which is subject to violent floods, there being very few lakes or ponds in the valley. A low pass reaches from Rangeley Lake south-eastward to Phillips, but I could find no signs of any great overflow that way. Length from Chesterville to Lisbon, 55 miles.

XX a. Winthrop — Leeds Kames.

An interrupted series of small ridges reaches from Leeds Junction to Winthrop village where it seems to run into Lake Maranocook Six miles to the north in Readfield a kame emerges from the lake and extends northward for one and a half miles. Probably the series extends under the lake. Length from Winthrop to Leeds 12 miles. A short kame is found a little east of Mt. Vernon village, another near West Winthrop, and another in the town of Jay, all of which may be tributaries of this system.

XXI. Freeport System.

An interrupted series of ridges extending from the south-east corner of Durham to the village of Freeport and perhaps farther south. On the north this system begins near the south brow of a pretty high range of granite and the kame is a broad ridge of sub-angular fragments of granite and is of morainal aspect. Near Freeport the gravel is entirely covered by the Champlain clays. Length about five miles.

XXI x or XXII x. Androscoggin River Kames.

Occasional short kames are found near the Androscoggin River from Livermore Falls southwards. The system is quite distinct from near the north line of Auburn through Lewiston to within three miles of S. W. Bend, Durham, and perhaps farther. It is here either a very zigzag series of short ridges separated by gaps of from one fourth of a mile to one mile in length, or more probably consists of two or more lines of ridges, part lying on one side of the river and a part on the other. This is a difficult series to trace, as it has been greatly modified both by the river and the sea, and has often been wholly or in part covered by valley drift or by marine sands and clays. Length 10 or more miles.

XXII. Canton — Auburn System.

This series begins near Canton Point on the Androscoggin River and extends southwards through a low pass to Livermore Village and North Turner, then as a broad series of plains through Turner to near the north line of Auburn, and then interruptedly past Lake Auburn and Taylor Pond to near the Little Androscoggin River, and possibly at one time it connected with XXIV in Poland. This great kame-stream drained an extensive area above Canton and a few ridges found in that direction in the Androscoggin valley may be a northern connection of the system.

Length about 30 miles.

XXIII. Buckfield — West Minot System.

Extends along a low pass from Buckfield southward through West Minot to the Little Androscoggin River about one and a half miles east of Mechanic Falls, and spreads into a plain which reaches south-easterly to near Lewiston Junction on the Grand Trunk Railway. These gravels have been greatly modified by the sea. North of Buckfield, kame gravels extend for three or more miles in the valley of the east branch of 20 Mile River, and are found at intervals along the railroad toward Canton, possibly extending to the Androscoggin River.

Length 15 or more miles.

XXIII a. Sumner — Buckfield Kame.

Found along the valley of the west branch of the 20 Mile River. It is doubtful whether this is the main kame, or that along the east branch of this river.

Length 6 miles.

XXIV. Androscoggin Lakes — Portland System.

This series of gravels was deposited by one of the largest Kame rivers in the state. The waters of the upper Androscoggin lake region united in one grand stream which flowed from Lake Welokennebacook southward through a very low pass and down the valley of Black Brook and Ellis River. This Black Brook pass is bordered by cliffs many hundred feet in height and forms a natural gateway through the mountain range which borders the lake region on the south. There are three other low passes through this range but I can find no proof of any extensive overflow except by this. From Rumford Point the course of the kame is up the valley of the West Branch of the Concord River and through a low pass in Woodstock to Bryant's Pond. In this part of its course it is called the Whalesback. It follows the valley of the Little Androscoggin to Oxford, where the river turns to the eastward, while the kames keep straight on southward through Poland, New Gloucester and Gray, here being a series of reticulated kame-plains. Northward from Walnut Hill Church there is a break in the system of a mile or a mile and a half. A broad ridge or solid plain extends from a little north of Walnut Hill to Cumberland Centre, where is another break of three-fourths of a mile in the system, and then another broad ridge reaches nearly to the Presumpscot River in Falmouth. Here is another break near the river. Not far south of the Presumpscot three ridges begin and reach southward to Stevens Plain, Westbrook, with some short interruptions. Here is another gap of about two miles and then we find extensive gravel bars, one on Bramhall Hill and another on Munjoy Hill, Portland. South of Portland is a gap in the series for nearly one mile and then begins an interrupted series of ridges which reaches into Scarboro, and perhaps to Old Orchard. From the Presumpscot south the gravels are arranged in two or more parallel lines of broad ridges or plains. In the jaws of the Black Brook Pass and on the down slopes of that stream and of the Ellis there are several long gaps in the system; on the up slope from Rumford to Milton the kame is continuous and composed of sand and fine gravel; near the col of the Woodstock Pass all but the coarsest material is washed away, and the pebbles are beautifully rounded, some being two, three, and even four feet in diameter and many of them almost spherical; and this is the characteristic of the kame as far as South Paris. Here it expands into plains, which are for the most part reticulated as far south as Gray, where they take the form of disconnected ridges or solid plains as before described.

Length about 105 miles.

XXIV x. Kennebago Kames.

These are reported by Mr. Huntington, of the N. H. Geol. Survey, as found in the Kennebago valley about twelve miles north of Lake Mooselocmaguntic. Connections obscure.

XXIV a. Andover Gravels.

The sand and gravel plains about Andover village were brought down from the valleys of the West Branch of Ellis River, and of Sawyer Brook. Part of these gravels are of kame origin.

Length about 10 miles.

XXIV b. Locke's Mills Kames.

An interrupted series of kames extends from Bryant's Pond to Locke's Mills. At this point two kame-streams joined, one coming from Bethel, the other from the direction of Bean's Corner and Bear River, but kames cannot be traced far in either direction before they are lost in abundant valley drift.

Length 8 miles.

XXIV m. West Cumberland Kame-Plains.

A broad rounded plain of gravel is found at West Cumberland, and from thence a series of plains, obscurely reticulated, and from one half mile to one and one half miles broad, extends westward for about four miles. The stream which deposited the western portion of these plains came down a valley which extends to Gray village, and hence these West Cumberland plains may be a delta of System XXIV. The eastern part of the plains may have been thrown out by XXIV along a low pass lying just to the west of Walnut Hill.

XXV. Casco — Windham System.

So far as now known this system begins in Casco in a low pass which forms the divide between Thompson and Rattlesnake Ponds. It passes through and under the latter named pond, as well as Panther Pond, and thence as a broadening series of kame plains to Raymond and North Windham. It then developes a double line of discontinuous plains and ridges extending southward through the western part of Windham and across Gorham into Scarboro. Systems XXIV, XXV, XXVI and XXVII all meet in the vicinity of Saco and Scarboro, and it is difficult in that region to distinguish between them.

Length of system about 30 miles.

XXVI. Bethel — Saco River System.

This extends from the Androscoggin Valley in Bethel, down the valley of Crooked River, expanding into kame-plains south of Waterford. At the mouth of Crooked River, the distinction between the kames and the valley drift is well defined. The river, where it flows into Sebago Lake, has filled up the lake for a long distance with a delta of valley drift, and all river deposits must always have gone the same way,— straight ahead into the lake. A series of reticulated ridges leaves the valley proper and runs south-westerly past the foot of the so called Bay of Naples and disappears in the deep bay which forms the north-west angle of the lake. This bay is credibly reported as four hundred feet deep, and as the lake is two hundred and forty-seven feet above the sea, it must therefore occupy a true rock basin. Two or three miles from where they run into the lake the kame-plains reappear, not far north of the mouth of North-west River, and as a broadening series continue along the west shore of the lake and thence along the east side of the Saco River to Buxton or beyond. Near the south end of Sebago Lake, this system sent off a tongue of kame-plains south-easterly into Standish, which plains end on the east in a steep bluff beyond which is ordinary till. These plains formed a dam across the old channel of the Presumpscot, which ran in a straight line from the present foot of the lake south-easterly to near Saccarappa, and they forced the river to its present outlet, which is seven miles to the north-east of the foot of the lake. The level of the lake is at least one hundred feet higher than it would be but for this dam.

Length 65 miles.

XXVI a. Naples Kame.

This extends from near Sebago Lake northward along the west side of the "Bay of Naples" or Brandy Pond. About one mile north of Naples Landing it runs into Long Pond and can be traced at intervals in the lake as far north as Bridgton Landing.

Length 13 miles.

XXVII. Fryeburg — Saco River System.

An extensive series of kame-plains reaches from near Fryeburg Village nearly east to the Saco River and borders the valley for many miles below there. Some of the high level gravels in Fryeburg were deposited by currents coming from the direction of Conway. There are a few signs of kame-streams converging from the north in the wide Fryeburg Basin, but there seems to have been no overflow that way from the Androscoggin Valley. This system receives a few small branches from the north at various points below Fryeburg, which are not yet mapped.

Length, about 40 miles.

XXVIII. Conway — Ossipee — Mousam System.

A large part of this great system lies in New Hampshire and has been described by Mr. Warren Upham in the Geological Reports of that State. In New Hampshire it extends from Conway past Ossipee Pond to Balch's Pond in Wakefield. In Maine the system has bordered both the Great and Little Ossipee Rivers with abundant kame-plains which reach as far east as Cornish and Limerick. The main outlet was southward from Balch's Pond down the Mousam Valley, past Springvale into Wells. For many miles this system consists of reticulated plains from one-half mile to four miles wide, and of great depth.

Length from Conway to Wells, 55 miles.

XXVIII a. Ossipee — Cornish — Kennebunk Kame-Plains.

A broad series of reticulated plains extends from Ossipee Lake eastward along the valley of the Great Ossipee River. A little west of Cornish these plains turn abruptly southward through Cornish, Limerick, Waterboro and Alfred to Kennebunk, following a line of low valleys.

Length, about 50 miles.

XXVIII aa. Central Parsonsfield — Alfred Kame-Plains.

The last named series gives off a connected series which leaves it in the Great Ossipee Valley, passes southward along low passes through Central Parsonfield and the north-east corner of Shapleigh to rejoin the same series near Alfred Village.

Length, about 35 miles.

XXVIII ab. West Parsonsfield Series.

Another series of reticulated plains leaves the Great Ossipee Valley and extends southward along a low valley which is not far from the State line. It joins the main system not far from Balch's Pond.

Length, about 10 miles.

XXVIII b. Little Ossipee Kame-Plains.

These extend eastward from the main system in Shapleigh to meet XXVIII a south of Limerick. Length five miles. Near North Shapleigh, in the angle between these plains and those extending down the Mousam, is a flat plain of fine sand. It seems to mark the site of a lake whose barriers on three sides were the kame-plains, assisted perhaps by the ice, while a range of hills is on the remaining side. Although the kame systems found in lee of the White Mountains are not so long as those in the eastern part of the State, yet the amount of classified material found in them is vastly greater. This system unmistakably branches like a river at its delta.

XXIX. Acton — Wells System.

Near the top of a granitic range and about one mile north of South Acton, two ridges begin within a short distance of each other and run southward by quite different courses, one keeping in a valley that leads eastward into the Mousam, and soon leaving it and making its way southward over a low col and along a low valley, the other zigzagging along the top and sides of a hill one hundred or more feet above it. They soon unite with a third small ridge and together extend through the eastern part of Lebanon, and through North Berwick into Wells. From Lebanon south, the system takes the form of reticulated plains. A large ridge in Wells which re-curves northeastward and is known as Maryland Ridge may belong to this system or to XXVIII or to both. The plains of this system and XXVIII seem to unite not far north of North Berwick Village. A few ridges south of Garvin's Pond may form a northern extension of this series but the connection is obscure. In Acton the gravel of this system is very angular, most of it showing hardly any signs of water wear, although plainly classified by water.

Length 28 miles.

XXX. West Lebanon System.

Extends from North-east Pond along a low pass through the western part of Lebanon, throwing out scattered plains in various directions. Not fully explored. May extend to Berwick.

Length perhaps 8 miles.

XXXI. East Rochester — Dover System.

A series of kames begins in the valley of Salmon Falls River not far north of East Rochester. It crosses from the eastern to the western side of the river at East Rochester, and from there the series is said to be nearly continuous to Dover, N. H.

Length 10 or more miles.

TOPOGRAPHICAL RELATIONS OF THE KAMES IN MAINE.

The kames are found at all elevations above the sea up to about 1,600 feet. At its north end System II is about 900 feet above tide water, and on the south it probably runs into the sea. It forms two series of kame-plains, one on the Tomah Stream at an elevation of about 350 feet, and one at Meddybemps Lake at 250 feet. Systems VIII and IX, north end about 700 feet; middle about 300; south end Deblois Plains, 200 to 300. System X, north end 1046; south end in Penobscot Bay. System XXIV, north end about 1,600; on the south it ends in the plains near Scarboro and runs into the sea. Short systems like XIV are but little higher on the north than at the south end. Almost all the kame-plains of the State are at elevations of 300 feet above the sea or less, though a few approach 600. These plains are only found in wide valleys or in level regions.

Only in a few cases is there any sign of the kames being deflected by hills less than one hundred feet high. They freely cross low transverse hills, even when a little deflection would give them a course through a valley. Apparently the minor details of the courses of the kames were determined by the local features of the glacier itself; and these latter bore no invariable relationship to the small elevations or depressions of the underlying land surface. Many times I have thought I saw some such relationship and then perhaps not five miles away would be found exactly the opposite. But there is one relationship of the kames to topography which is, so far as I have yet observed, invariable. No instance is known of a kame crossing any hill where, coming from the north, one would have to rise more than about two hundred feet in crossing it. Hence the kames never penetrate the high east and west ranges with which the state abounds except by low passes. This may not be the lowest or most direct valley and very often is not the line of natural drainage. In fact the courses of the kames are curiously arbitrary, if only the present surface features of the country are considered. In general their courses are not deflected east or west by the hills nearly so much as are the streams of to-day. For instance, IX crosses the Penobscot in Medway, and then goes south by a more direct route than that of the river, crossing it again at S. Lincoln. This same kame runs lengthwise of the valleys of six streams and crosses the valleys of six or seven. At the mouth of Aybol Stream IX b leaves the Penobscot, there trending south-easterly, and goes about twenty miles eastward, part of the way even north-eastward, and then turning south, it crosses the Penobscot near the mouth of the Millinockett Stream, a route somewhat longer than one along the Penobscot. From this point the kame has greatly the advantage in directness of course over the river. The latter makes a long detour eastward to Mattawamkeag, while the kame runs nearly south, crosses the Piscataquis, and then the Penobscot again near the north line of Argyle. It also runs lengthwise of the valleys of five streams. The reason these kames run lengthwise of the valleys of so many streams is that they follow up a stream to its head, cross a low col, and then run down a valley sloping in the opposite direction. None of these cols, however, are more than two hundred, in one or two cases perhaps two hundred and fifty feet above the valley *lying to the north.* Many other instances might be given where a kame leaves a valley and afterward rejoins it, notably XI and XXIV.

No instance is known where a kame, after entering a valley bordered by hills more than two hundred feet high, has left it, however crooked may be the valley. Usually when in a broad south-east valley, they do not leave it, even when the bordering hills are considerably lower than two hundred feet.

The practical application of these principles is obvious. Latterly my methods of exploration have been largely topographical. The first and usually the chief part of the problem, is to determine where are the low passes. Often a reconnoissance of a few minutes from some sightly place will reveal more than the explorer could gain by hours and sometimes by days of marching, especially in the wilderness. In a level region there is no means of foretelling the course of a kame, but in a hilly or mountainous country this unfailing relationship between the kames and low passes is of inestimable service to the explorer. For there are gaps in all long kames where they wholly or for the most part disappear, and one would hardly know where to look for the continuation, except for some such topographical guide.

At their northern extremities the kames invariably originate in places favorable for the collection of a large amount of water, either in level plains, or on broad slopes, or near the top of a low divide, where we may suppose they drained the country to the northward. They originate in lee of a mountain only when a drainage basin lies there. The larger is the drainage basin in which a kame originates, the larger, in general, has been the flow of water, as is shown by the amount and kind of material transported, etc. In this respect they exactly correspond with ordinary streams of water.

The fact that the kames penetrate our hilly regions only along low passes makes the kames seem to have a special fondness for low and level regions. But kames, when crossing hills, or when near the height of divides, or in narrow passes, or on steep down slopes commonly disappear, wholly or for the most part, while they are largest on level ground or on up slopes. This makes the conspicuous kames appear more frequently in level and swampy regions, while on the steeper and rougher ground the kames may consist of only an occasional bed of gravel or a few scattered pebbles. Obviously, however, a little dome of gravel or rounded pebbles in a place where no modern stream could have deposited or rounded them, is as truly an organic part of the kame as those parts where it appears as a large ridge — providing the gravel or pebbles are found along a line of probable overflow. And the evidence would be complete, if, after tracing a broken series of water-washed materials in this way, we should presently come upon a well developed kame keeping the same general direction. It is in this way that the kame systems here described have been traced. All have gaps, but all lie along continuous lines of valleys or over level ground, and all are practicable lines for railroads.

When following valleys the kames are sometimes found along the axis, but more often they zigzag somewhat, so that they now approach one side, and now the other. Not seldom are they found zigzagging along the sloping sides of a range of hills, sometimes a hundred or more feet above the valley, and in such situations, if the slope is steep, they may appear much like a terrace, the result of lateral sliding. No tendency to follow the top of a hill has yet been made out. In fact, as already stated, the only surface features which seem to invariably determine the location of kames, are drainage basins, and hills more than about two hundred feet high, measured on the north. In many instances kames cross the beds of lakes, sometimes for many miles, and can be traced under the water.

External Features of Kames.

The simplest form is that of a simple ridge meandering like a river, and which may be one hundred and even one hundred and forty feet high, with corresponding variations in breadth and angle of slope. They are often broken, sometimes owing to erosion by streams since deposition, but more often the original deposit was discontinuous. This usually happens wherever we should naturally suppose that the current of the kame-river was very rapid. A ridge frequently forks into two ridges which soon meet again and enclose a funnel or sink, which if it be deep enough, may form a lakelet without a visible outlet. Or we may have a system of ridges, connected by cross ridges, called reticulated ridges by Professor N. S. Shaler, and in this paper also called a plexus, or kame-plains. Every long kame expands at some part of its course, generally near its south end, into these plains. System XI is an apparent exception, but the plains of this system are probably under the sea. System XVIII also appears to be an exception. In certain places a kame expands suddenly into a modification of the kame-plain, in the form of a broad peak or of a flat topped plain in which there may be a few funnels, and which may be one-fourth of a mile or more long and as much as three-fourths of a mile wide. To the north and south of this plain or enlargement, the kame consists of only one or two ridges of ordinary size, or may disappear entirely. The "Plain" shown on the map of Rev. G. F. Wright as found a little southwest of Andover, Mass., is probably similar to the deposits here described. In Maine they are called "pinnacles" or "mountains" being from forty to more than one hundred feet higher than the rest of the kame. For an account of somewhat similar but more continuous deposits, see description of systems XVII, XVII a, XVIII XX and XXIV.

External Features of Kames which have been under the Sea.

The sea produced a great change in the physiognomy of the kame, at least in exposed situations. The slopes of the kame that has not been under the sea are generally steep, often as steep as loose materials will lie, and its top often forms a sharp ridge or series of hummocks, particularly if it be a pell-mell kame. After exposure to marine waves and currents the kame was either covered out of sight by marine clays or took the form of a rounded gravel bar whose side slopes approach the angle of stability as shown by the sand or gravel bar of the coast. Four years ago this difference in appearance convinced the writer that the kames were not of marine origin. In Maine during the Champlain period the sea stood between two and four hundred feet above its present level. In valleys tidal currents passing back and forth have sometimes swept great gaps in the kames, have strewn them far and wide, or piled them up in the form of bars. Where no modern surface stream has ever flowed, marine currents have re-classified a kame into bars arranged *en echelon*, that is, obliquely to the kame but parallel to the course of the tidal flow. The meanderings of kames have by this means been rendered more regular and rounded bars have been left at the outsides of the angles. The narrower parts of the ridges have usually suffered more degradation than the broad parts, whereby the latter often form "pinnacles" of erosion. When the kame is nearly covered by marine clays, a line of these swells or domes is often the only visible sign of a kame. Where kame plains have been under the sea the funnels between the ridges have been washed full of sand or clay, and the whole has been reduced to a flat plain, bordered by sand plains derived from the materials washed away from the kame-plains by the waves and currents.

INTERNAL STRUCTURE OF THE KAMES.

An obscure anticlinal stratification is seen on the surface and flanks of all kames, caused, in the judgment of the writer, by the sliding down of their materials, partly while the ice walls of the kame-stream were melting, and partly under the subsequent actions of rains, etc.

1. *The Pell-mell Kame.* In their interiors many kames are composed of a very confused mass of sand, gravel and pebbles, either indiscriminately mixed or with a few faint traces of a former stratification. Even in the most confused mass, the majority of the flat pebbles are usually placed horizontally, which of itself gives an obscure appearance of stratification. This is more marked where the kame is composed of fine and slaty materials than where composed of coarse, granitic debris. In general these pell-mell kames are more irregular and hummocky in external form than those which retain their strati-

fication. When crossing transverse hills and valleys, a kame is sometimes stratified on the hill and only a pell-mell mass in the valley.

2. *The Stratified Kame.* This is the more common of the two. In many cases the lower layers are of finer materials than the upper. These lower layers rest upon the lower till, but thus far I cannot find any deep channel cut in the till. In the jaws of a few narrow passes there is but little till to be found, and it may have been washed away by the kame river, but if so, not along a well-defined channel with walls of till. Most of the large longitudinal sections examined show that the water flowed from north to south, as attested by the dip of the lines of stratification. The peculiarities of the stratification of the kames in Maine, are so similar to those which have been already well described by observers on both sides of the Atlantic, that no further particulars need now be added.

For the study of the internal structure of the kame that has been under the sea there are excellent facilities in Maine, although the number of excavations and exposed sections is not so great as could be desired. I have been able to learn much as to their composition by means of wells.

There was, first, the original kame, already described as a ridge of varying breadth and height, and often with steep slopes. Upon the flanks of this, and sometimes completely covering it, are marine clays which may contain a quantity of gravel for some considerable distance back from the kame. Capping the whole is a mass of stratified sand and gravel which is the re-classified top of the original kame, now strewn by the sea on either flank and usually covering the clays on either side for five feet or more. The under kame is generally bluish in the color of its materials, the upper brownish. The upper kame is in great part not a kame at all but a marine gravel bar capping the real kame as well as its bordering clays. Occasionally a section shows a kame completely covered by clay, which in turn is overlain by an "upper kame." Here I suppose the clay was deposited over a low place in the kame, and the upper gravel was washed there from the higher parts. This longitudinal transportation is fully proved by lines of stratification in the upper kame. Upon the top of the upper kame may often be found angular boulders, which, as stated elsewhere, I refer in part to stranded ice floes. The angular and sub-angular character often shown by the smaller stones of the upper kame indicates that much of fine material may have been contributed by the floes. Near Kenduskeag Village in the upper kame are found sand beds showing curved and contorted lines of stratification which dip 50° and some layers 60° obliquely toward the centre of the kame. The appearance is as if here a floe grounded. In the upper kame the stratification is arched or combined with a tendency to dip lengthwise of the kame, showing the action of alternating currents in that direction. The evidence of the marine origin of the clays which overlie the kames is conclusive. Leda, Mya, Balanus and other genera have been found in the stratified and undisturbed clay which filled a low place in a kame, and directly on top of the ridge.

MATERIALS OF THE KAMES.

At the northern ends of the kames the sand and gravel is much less worn and rounded than farther south. Some instances of this are given in the descriptions of systems II, VIII and XXIX.

When kames pass from a region of one kind of underlying rock into another formation, there is a corresponding change in the materials, as is shown very clearly in the description of system IX. The facts show that the drift in the kames was in general greater than ordinary glacial drift. In other words, kame drift is glacial drift plus a variable amount of water drift. Occasionally we find large angular boulders overlying the kames, which probably tumbled down upon the kame from ice walls, as has been suggested by Mr. Upham. These may not have been transported at all from the places where they fell.

The materials of the kames differ much in fineness. In regions of slate and schistose rocks, the kames are usually composed of fine gravel or sand or small pebbles, while in granitic regions they contain many large pebbles and often present somewhat the appearance of moraines. The fineness of materials is also greatly influenced by the slopes of the region traversed by the kame, as is shown in the descriptions of many of the systems.

GENERAL CONCLUSIONS.

The following conclusions in addition to those already stated appear to be justified by the facts thus far observed in Maine. The writer believes that very much remains to be discovered as to that manifold problem, the behavior and history of the great ice-sheet of eastern North America.

BOULDERS. Before the glacier came, the rocks were deeply broken up and disintegrated, and many of the fragments were weathered into rounded boulders.

GLACIAL EROSION. Many facts, some of which are referred to elsewhere in the description of the lower till, tend to show that the glacier did not greatly modify the relief forms of the land, unless it be near the coast. Almost the only signs of sub-glacial streams to be found in the state are found near the coast, where they have excavated large pot-holes, and may have eroded the rocks in the valleys. The facts observed are in favor of the theory advanced by Professor W. H. Niles [1] that glacial streams are more active agents of erosion than the ice itself.

DISTRIBUTION AND SIZE OF THE KAMES. If we should study large areas of country we might find that a difference in the times of melting of the different parts of the glacier had some effect on the distribution of the kames. Within the field of my exploration their size and distribution depends partly on the nature of the underlying rock, since that affects the nature of the upper till; partly on the supply of water as determined by the size and positions of drainage basins; but chiefly upon slope. Where the slope was very steep all the kame material was washed from the bed of the kame-streams, as doubtless happened in our steep mountain valleys. Where the general slope of the country southward was very gentle, only the finer material was transported. In the St. John valley the slope is northward or eastward and only local gravel ridges have been found. The slope of the ice surface must be taken into the account, as well as that of the underlying land. This matter of slopes has probably been the chief factor in determining the distribution and size of kames west of New England. The longest systems of kames may be expected where the glacier covered the longest down slopes, and most of the kames will probably be found within one or two hundred miles of the terminal moraine.

THE KAME-STREAMS. In general these streams flowed southward, but in the cases of four short kames it is not yet determined which way they flowed. That they were confined within ice walls is shown by the fact that they cross hills and do not follow the lines of natural drainage. The map shows that they branch like rivers. They flowed with greater velocity in some parts of their course than in others, as is shown by their behavior on up and down slopes. They meander like rivers. They run from higher to lower levels: that is, though the kames have their local ups and downs yet the system as a whole is higher on the north, thus accounting for the slope necessary for a stream. The ice surface probably had a corresponding slope. In short, I know of no characteristic of an ordinary river running in an open channel which these kame-rivers do not seem to have had.

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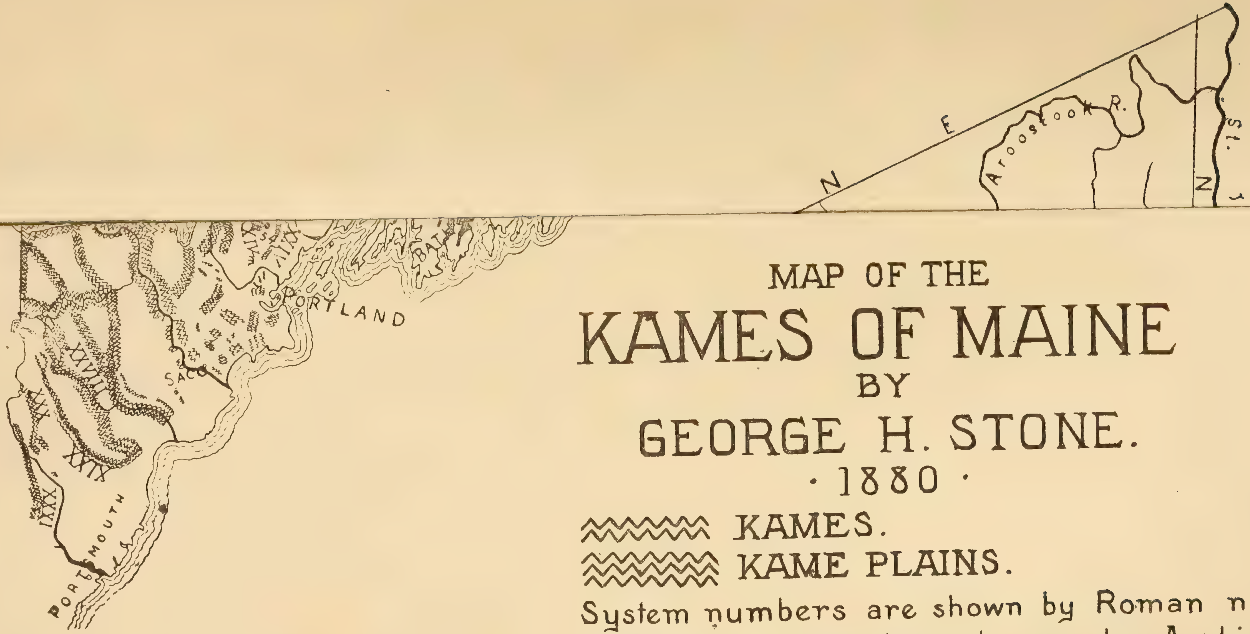
[1] Proc. Boston Soc. Nat. Hist., XIX, 330-336.

The difference in their rate of flow in different parts of their courses shows that they could not have been sub-glacial streams confined within ice tunnels of uniform size. If they were sub-glacial, their channels must have been largest where the flow was slowest, and it would seem as if the erosive action of running water at 32°F. ought to act in just the opposite way. Again, if there were sub-glacial streams at all, they ought to find their way along a wide valley like that of the Penobscot. The fact that IX and IX b cross that valley four times and are thereby forced to take a course one or two hundred feet higher than they would find along the valley, is fatal to the theory that they were sub-glacial. I do not see how sub-glacial streams could be so unmindful of the land surface as were the kame-streams. The latter run over hills when they could run around them by a deflection no greater than the kames are constantly making. So too, sub-glacial streams ought to wear farther into the ground moraine than the kame-streams have done. The rarity of large boulders in the kames has with good reason been urged by Mr. Upham as showing that the kame rivers were not sub-glacial. For these and other reasons it seems to me quite certain that most of these kame-streams were in superficial channels. Near the coast there are signs of sub-glacial streams and some kames may have been formed by them.

MODE OF TRANSPORTATION OF KAME MATERIAL. We have first and foremost, the ordinary transportation of running water, increased, probably, by ice-gorges. That there was a vast flow of water in these rivers is evident when we consider that our spring floods would then last all summer, increased probably by a large rainfall. These rivers must have often been two hundred or more feet deep when crossing valleys. The narrowness of their channels must have increased their power of transportation. Another mode of transportation is by means of floating ice, as has been pointed out by Rev. G. F. Wright. During the cold season thick ice would form in the bed of the kame river. This ice when broken up and carried down by the spring floods would often carry with it fragments of rock. In this connection it is instructive to examine the beds of mountain streams, such for instance as those which flow into the Androscoggin over the thick sheet of till which covers the northern slopes of Mount Moriah, between Gorham, N. H., and Shelburne Bridge. The force of the currents has washed away all but the largest pebbles and boulders. And yet, even on that steep slope, these torrents, for such they are in time of flood, do not have power to transport boulders two or three feet in diameter, except slowly. Now in the kames we find pebbles two or three feet in diameter mixed with stratified gravel and sand. Transportation by floating ice would afford a satisfactory explanation of this, though not the only one.

Pell-mell Kames. We may account for these by at least two theories. They may have been deposited above the ground on the ice. When the ice melted they would naturally settle down irregularly and thus their stratification might be obliterated. Or we may suppose, after their deposition, a flow of the ice sufficient to confuse them. In a few places I have thought the latter theory probable, but in general the stratified and pell-mell portions so alternate as to require the explanation first given.

Kame-Plains. There are cases where a kame ends in plains which cannot yet be proved to be deposited within ice walls. Most of these have been modified by the sea and their testimony is not conclusive either way. It is abundantly proved that many of the plains were deposited on the ice or within ice-channels. This is well shown at Sebago lake as is described elsewhere (system XXV). If the kames were deposited in surface channels in the ice, the plains would naturally be formed as follows. These systems of reticulated ridges are found in regions that are level or of so gentle slope that the power of transportation of the water was greatly diminished from what it was farther to the north. Hence the channels of the streams soon became filled and then the streams overflowed into new channels running in various directions and of various depths. Where these channels covered or enclosed an island of ice, there was left when the ice melted a funnel or a lakelet. This theory also very well accounts for the tendency of kame-plains to form on one side of the main or original kame if it be very large. The ice that filled the bed of Sebago Lake must have been from four to six hundred feet thick in order that system XXIII might pass right over the basin. In Moosehead Lake it



N
E
N
St. J
Aroostook R.
BATH
PORTLAND
SACO
PORTSMOUTH
XIV
XXVII
XXIX
XXX
XXXI

MAP OF THE

KAMES OF MAINE

BY

GEORGE H. STONE.

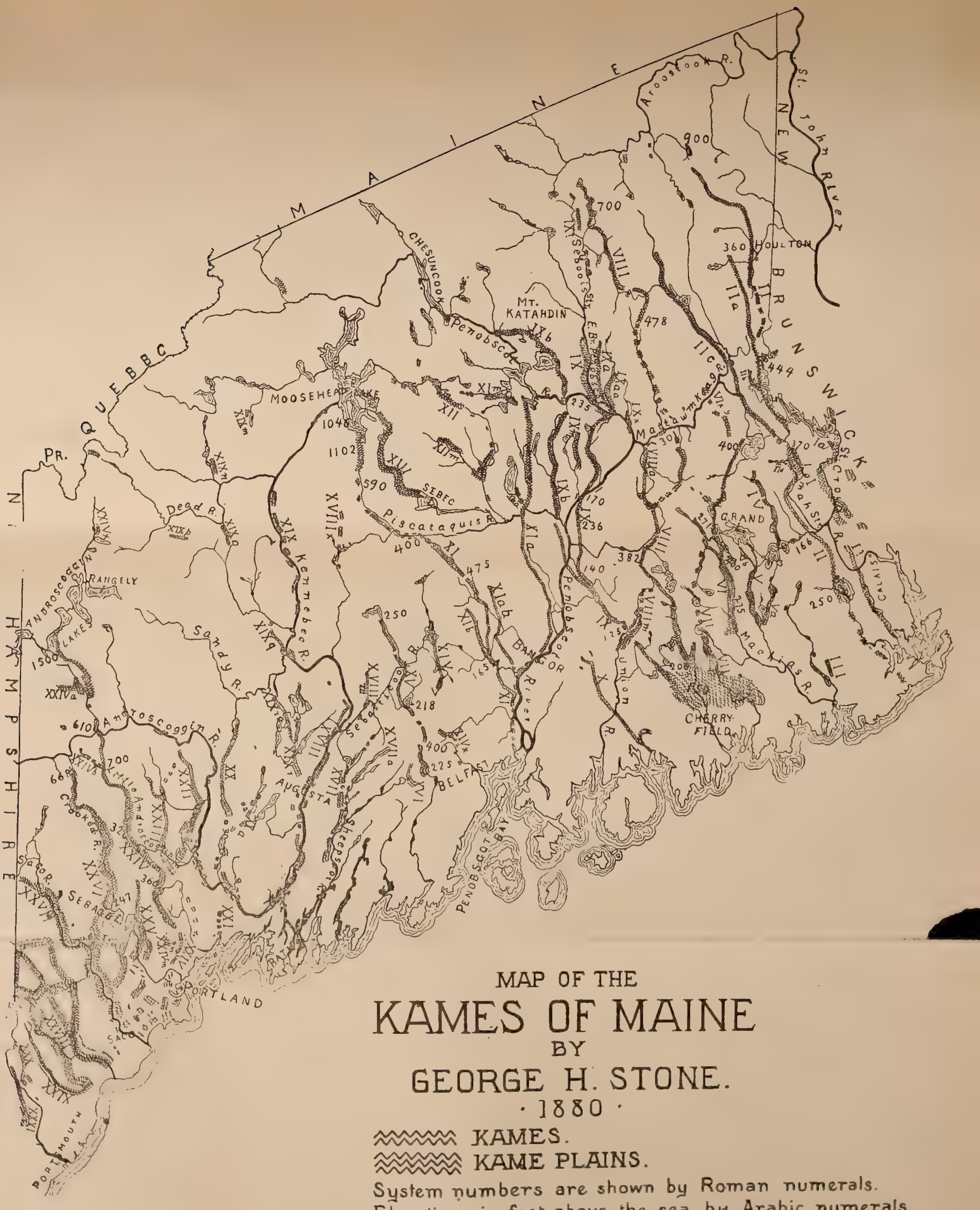
· 1880 ·

〰 KAMES.

〰 KAME PLAINS.

System numbers are shown by Roman numerals.

Elevations in feet above the sea by Arabic numerals.


M A I N E
QUEBEC
PR.
N. HAMPSHIRE
NEW BRUNSWICK
St. John River
Aroostook R.
900
700
HOULTON
360
478
444
CHESUNCOOK
MT. KATAHDIN
Penobscot R.
E. Br.
Seboois St.
MOOSEHEAD LAKE
1046
1102
590
SEBEC
Piscataquis R.
400
475
235
170
236
140
382
Mattawamkeag R.
300
400
370
166
250
275
GRAND
St. Croix R.
CALAIS
Machias R.
Union R.
CHERRY FIELD
200
BANGOR
Penobscot River
165
125
250
218
400
225
BELFAST
PENOBSCOT BAY
Sebasticook
Sheepscot R.
AUGUSTA
BATH
Kennebec R.
Dead R.
Sandy R.
RANGELY
Androscoggin LAKES
1500
Androscoggin R.
610
700
Little Androscoggin
Crooked R.
Saco R.
SEBAGO L.
PORTLAND
SACO
PORTSMOUTH
I
II
IIa
IIc
III
IV
V
VI
VII
VIII
IX
IXa
IXb
X
XI
XIa
XIb
XII
XIII
XIV
XV
XVI
XVII
XVIII
XIX
XIXa
XIXb
XX
XXI
XXII
XXIII
XXIV
XXIVa
XXIVb
XXV
XXVI
XXVII
XXVIII
XXIX
XXX

MAP OF THE

KAMES OF MAINE

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〰 KAMES.

〰 KAME PLAINS.

System numbers are shown by Roman numerals.
Elevations in feet above the sea by Arabic numerals.

must have been far deeper yet. In general during the kame period the thickness of the ice was three hundred feet or less.

RELATIONS BETWEEN THE KAMES AND THE UPPER TILL.

1. They were contemporaneous formations.

2. Both were derived from the same morainal matter scattered through the ice, the difference being that the kames have been classified by water. Yet kames sometimes contain large unclassified masses of upper till which probably slid down into the bed of the stream and defied classification by the water. The word classification is not here used as synonymous with stratification. The pell-mell kame has been classified by water but is not now stratified.

3. A part of both formations were glaciated, but in the kame the glaciation has been more or less effaced by water wear.

HOW WERE THE MATERIALS OF THE KAMES COLLECTED?

Evidently a part was already in the ice at the place where the channel of the kame river was formed, and was laid bare as the ice melted or was eroded. This will account for the presence of many of the large pebbles in the kames. Another part was brought to the main channel by tributaries from the sides. This was composed for the most part of fine materials. Occasionally small gravel beds are found not far from the kames, which I have thought might be the gravels of such tributaries, but their fewness is surprising. The narrowness of the channels of many of the kame-rivers as compared with their depth has often made me suspect that these channels were so deep that the sides flowed inward toward each other, the stream eroding the ice as it advanced. The flow of the ice as a whole must, over a large part of the state, have ceased at the time of the deposition of the kames, and such a flow of the walls inward could not have been very great in amount. If such a flow occurred, it would help to bring together kame material.

General Meeting. March 17, 1880.

The President, Mr. T. T. Bouvé, in the chair. Twenty-six persons present.

The following gentlemen were elected Associate Members: Messrs. F. G. Darlington, Pittsburg, Pa.; Dr. H. C. Haven, Prof. Henry W. Haynes, W. G. Corthell, John Osborne Sumner, Boston; and John H. Thurston, of Cambridge.

The following paper was read:

ON THE ORIGIN OF THE IRON ORES OF THE MARQUETTE DISTRICT, LAKE SUPERIOR. BY M. E. WADSWORTH.

However distant the Lake Superior district may seem to us, it is eminently fit that its geological problems should be discussed before this Society. The earlier explorers were largely members of this body, and questions relating to the geology, mineralogy, and physical geography of that most interesting region have been debated from time to time here. Of the members of this Society who have been more or less actively engaged in the exploration of the Lake Superior district, we may mention both Agassizs, Desor, Foster, Jackson, Marcou, Marvine, Pumpelly, the brothers Rogers, and Whitney; while on the pages of the Society's publications over forty papers relating to the district can be found.

One of the most important and interesting questions relating to Lake Superior geology is the question of the origin of the iron ores. It is important and interesting not only from a scientific point of view, but also from an economic standpoint. If it be asked how its origin can be determined, we reply that we believe that every geological formation, whether chemical, mechanical or eruptive, contains within itself and in its relations to other rocks, the story of its origin and subsequent history. This story is to be read with greater or less facility, according to the amount of obliteration subsequent changes have produced upon the marks left by the preceding events; also according to our knowledge of, and skill in reading, these characters. It is necessary in such cases to proceed from the known to the unknown. We are to study the structure and relations of rocks, whose origin is known; and when we find the same characters in other rocks of unknown origin, we are enabled from these marks to determine the origin of the rock of unknown history. Eruptive, chemical, and mechanical deposits are being formed to-day on the earth's surface. Their origin is known so far as it relates to their present position. Other formations have their origin known from historical record. The various known cases give the data for working back into the past history of the rocky crust of the globe. In this study it would seem that the characters and relations of a formation must prove its origin; and it is not allowable to assume because *some* material of a certain kind is being deposited in one way at the present day that *all* material of that kind must have been laid down in like manner, unless its characters and relations are the same. It is not proper for us to decide *a priori* the origin of any formation, until its conditions have been studied. Furthermore it is not allowable to take characters common to formations of unlike origin as proving the rock in question to belong to one instead of the other. We must choose as deciding points those features that are exclusively, so far as known, confined to rocks of one origin. If the diagnostic features are common to rocks originating in two or three dissimilar ways, their discovery in the rock in question only shows that it may have been formed in any of the two or three ways, but does not show which one.

Doubtless some one at this point, if not before, exclaims: "What nonsense! does not every geologist and petrographer know these things? Why should a paper open with such trite and commonplace remarks?" We beg the pardon of our critic, and urge in excuse the fact that these simple and obvious rules have been repeatedly violated in the study of the questions before us. Furthermore the history of geology is fraught with illustrations of the neglect of these and other, perhaps simpler, rules. In applying the principles above given in studying the question before us, it is necessary to study the rocks *in situ* and accept the evidence they there present.

Taking up the problem of the origin of the iron ore and its associated jaspilite it is proper to remark, in order to save time, that except in some few secondary and subordinate cases, they do not, so far as we have observed, present the characters of vein-stones. All writers, so far as we are aware, agree upon this point, and the evidence has been given in their writings; hence it is not necessary to discuss the question here.

It remains for us to examine whether the ore and jaspilite were deposited as sediments *in situ* or are of eruptive origin, since both views are held. That the ore and jaspilite are of common origin and are inseparable parts of the same formation is universally acknowledged. Their interdependence is such that the relations of one to the country rock give the relations of the other.

The question now arises, what are the grounds upon which the sedimentary origin of the ore and jaspilite has been urged by different writers.

The sedimentary origin is advocated on the following grounds:

(1) Bog iron ores are forming at the present day.

(2) On account of the banding or lamination of the ore and jaspilite.

(3) The bandings show foldings and contortions.

(4) The jaspilite and ore are jointed and show cleavage.

(5) The associated rocks are sedimentary and on account of the alternation with schists, the ore and jaspilite, as well as the schists, must be metamorphosed sedimentary rocks.

(6) The presence of phosphoric acid.

1°. Taking up the evidence advanced in favor of the sedimentary origin of the jaspilite and ore in order, we meet first the formation of limonite in modern times. It is urged, since limonite is now formed, that all workable iron ore must have been produced in the same way. Iron ore is produced at the present day by volcanic eruption and by sublimation. Would it then be proper for us to claim that since iron is and has been placed on the earth's surface in modern times by eruption and sublimation, that all workable iron ore in past times was produced in one or both of these ways? Certainly, as fit and right as it is for others to hold, that because bog iron is and has formed on the surface, that hence all past ores must have been formed as bog ore. However, neither of these arguments appears to us to be sound, for the only correct method is to study the deposit in question and decide as to its origin from the facts it presents. It is to be distinctly understood that we are talking only about the deposits in the Marquette district that we have personally studied, and not about others there or those of other districts.

It seems that those who hold to the sedimentary origin of iron ores draw a line between those deposits which can be worked with profit and those that can not, in the present state of commerce. Nature, according to them, evidently drew the line between eruptive and non-eruptive deposits of iron exactly at this point. It is well known, as remarked by Prof. J. D. Whitney, if iron ores were more valuable than they now are, numerous dikes of basaltic and other eruptive rocks exist that would be worked for the iron ore they contain. We hold that as it is, such dikes have been and are now being worked, only their origin is denied.

In the case of the eruptive rocks the iron is in the state of hematite and magnetite, while it is necessary, if we adopt the bog theory, that the limonite should be transformed into hematite and magnetite in some unknown way. In the eruptive rocks the iron ore, except in places, is subordinate to the remainder of the rock; and in the Marquette district the ore is likewise subordinate to the jaspilite.

Let us again enforce the principle: whether the Marquette ore and jaspilite were formed as eruptive or sedimentary masses can only be told by studying them and seeing if they have the characters of bog ore or of eruptive rock. In this way only are we able to connect their present state with their past. It is not proper to begin with any of the modern formations of iron and theorize back until we reach the older ones, claiming that we have thus proved the way in which the older ones must have been formed. If our logic and science are correct in this *a priori* method, we simply show how the ore *might*, not *must*, have been produced. The *must* comes only from the study of the state of the ore and its relations: facts to which all the theories *must* conform. Again, we remark, we are not to be taken as advocating the eruptive origin of all deposits of iron as others do the sedimentary origin of all, but merely of such as we think show evidence of the former origin. Such ores as show internal and external evidence of sedimentary deposition we accept as sedimentary.

2°. The banding and lamination of the jaspilite and ore do not appear to us to be proof of sedimentary origin, since a similar banding is strongly marked in the rhyolites the modern lavas approaching nearest the jaspilite, in dikes of felsite, in furnace slags, etc. Allowance, too, has to be made for the alterations that have been produced in the rock since its consolidation. This structure is common to both sedimentary and eruptive rocks, hence *per se* is of no value either way. The structure of the banding does often show the origin of the rock when it has been studied with care. Those advocating the sedimentary origin of the above-mentioned ore have rested their claim on the simple fact that the rock was "*striped*," and not on the character of the banding. We have studied the banding and can find nothing in it that proves sedimentation or is inconsistent with that repeatedly seen by us in known eruptive rocks.

3°. The folding and contortion of the banding would take place in any rock whatever its origin, after it was in position, if subjected to proper conditions. A lava flow buried and subjected to the same compression and up-tilting, shows foldings and contortions as would a sedimentary rock in like position and subject to the same agencies. This we find to be the case in the older lava flows. Hence folding and contortion of banding in rocks, like the banding, is common to both sedimentary and eruptive rocks, and like the latter (banding) is no proof of either origin.

4°. Joints and cleavage planes are well known to be common to both sedimentary and eruptive rocks, hence their presence cannot be taken as proof of either origin.

5°. Whoever advanced the view that since the associated rocks were sedimentary, therefore the jaspilite and ore must be, probably intended it for a bit of facetiousness, since he must have been aware that this principle would prove the great majority of dikes and veins to be sedimentary. A dike passing through slate must be sedimentary because the slate is sedimentary! Do we not find rocks intruded through sedimentary ones in every position, both parallel with the stratification and oblique or perpendicular to it? Can any geologist ever have been so ignorant of the mutual association of eruptive and sedimentary rocks as to have soberly advanced the above idea? How then can the alternation of one rock with another be taken as proof that they both originated in the same manner?

It is generally accepted that the old copper-bearing basalts of Keweenaw Point are lava flows. Now they are interlaminated with sandstones and conglomerates. Does this prove that the sandstones and conglomerates are lava flows, or again does it prove that the lava flows are detrital just as the sandstones and conglomerates are? However absurd this line of argument may seem now, it has been applied in the past to the above-mentioned beds on Keweenaw Point. How quickly would the fallacy be seen, if we should claim that the Calumet conglomerate was a lava flow because it was interlaminated between two lava flows? Would such a supposition be any more erroneous than the one advocated for the iron ore, which would make a lava flow on a sea beach, afterwards buried in detritus, to be of the same origin as the detritus above and below it?

It seems that many geologists and most chemists use this course of reasoning regarding all eruptive rocks, except those of recent formation or those whose origin is immediately obvious. Why not study thoroughly in each case, the internal structure and the relations of a rock to its adjacent rocks before deciding upon its origin?

6°. The presence of phosphoric acid could only have been taken as proof of sedimentary origin by those who had no knowledge of eruptive rocks, since it is well known to occur in many of the latter. This has been shown both by chemical and microscopic analysis. Even if this were not the case, the presence of phosphoric acid could not be made proof of the organic origin of the ores of the Marquette district, since they are exceptionally free from phosphoric acid.

We have now taken up all the evidence which we are aware has been used to prove the sedimentary origin of the jaspilite and ore. The characters used as proof seem to be such as are common to both sedimentary and eruptive rocks or are of no weight.

It does not appear that those who advocate the sedimentary origin of the ore have ever made any careful study of its relations, but have rested their claim principally on the "striped" appearance of the rock and the contortion of the stripes. Of the more recent authors who advocate the sedimentary origin, it does not appear that Dana, Hunt, Lesley, Newberry, and Winchell have ever studied the rocks in place, or, so far as their publications show, have ever been on the ground. Of the others, Brooks, Credner, Kimball, and Wright, all except Credner appear to be mining engineers, who at the time of their examination of the region gave no evidence that they had made a special study of the history and origin of rocks, or were even stratigraphical geologists. We claim that questions of the kind above discussed belong to the domain of the petrographer, one who is conversant with both petrology and lithology, and are not in the province of the chemist, mineralogist, stratigraphical geologist, palaeontologist, mining engineer, or lithologist as such.

It now remains to give the evidence in behalf of the eruptive origin of the jaspilite and ore.

The prominent fact to be urged on this side is that wherever the contact of these rocks with the country rock could be studied, that contact was always an eruptive one. The phenomena of the contact of eruptive rocks with other prior existing rocks are well known and not easily mistaken by one familiar with their study, however much they may trouble the chemist, mineralogist, stratigraphical geologist, palaeontologist, mining engineer or lithologist.

The jaspilite and ore are found to break in various directions across the lamination of the associated rocks, to indurate them at the line of junction, to send stringers and tongues into them, to cut the laminae in every direction; in short, to behave always like an eruptive rock and never like a sedimentary one. No theory of deposition in fissures and cavities will account for these relations, since the internal structure and contact relations are not such as occur in this case. Further, it would be necessary to invert the strata several times in order to fill the cavities that exist in the same pit, since they hold every relation to the horizon; and lastly it would require the schists to be a formation of prior age to the iron ores, one that had been deeply buried, metamorphosed, and then elevated before the deposition of the latter.

It seems that Mr. Brooks, a mining engineer, whose authority has been generally followed upon the question of the sedimentary origin of the jaspilite and ore, found himself obliged to admit that in the Lake Superior mine there occurred masses which "appear like dykes of ore, squeezed out of the parent mass, which we may suppose to have been in a comparatively plastic state, when the folding took place; or they may have been small beds, contained originally in the chloritic schist, and brought to their present form and position by the same causes which produce the cleavage in the schist." (Geol. of Mich., I, 139, 140.) We thus see that Mr. Brooks arrived at a point where he was compelled to admit that the ore was in dikes, or at least had been in a plastic state. He further acknowledges that he is "unable to give any intelligent hypothesis of its structure." It seems that the Survey was abandoned at this point, the mines having been previously studied which offered the least obvious difficulties in the way of his theories. Had his work continued there is no knowing what views he might have held.

The efforts to prove the jaspilite and ore to be sedimentary required the assumption that they have, since deposition, been rendered plastic, that is have been protruded into other rocks as eruptive rocks are.

This admission involves certain things that appear not to be well established.

1°. We are not aware that it has ever been proved by any accurate, thorough observations by properly trained observers, that a sedimentary rock has ever been made *plastic* by natural causes; in other words, proof is wanting that a sedimentary rock has ever been found with the characters of an eruptive one. The burden of proof yet rests on those who hold that a sedimentary rock assumes the characters of an eruptive one. Hence we have here an unproved theory employed to prove another theory.

2°. It requires that the highly refractory magnetite, hematite, and siliceous jaspilite, all of which it is denied could have been fused as an eruptive product, should have been rendered plastic and fluent, while the easily fusible argillites and chloritic schists as well as talcose, sericite, and other schists, sandstone and quartzite, neither became plastic, nor showed any signs of it. While rocks of both basic and acidic character, some even of nearly pure silica, are found in contact with ore and jaspilite which show eruptive relations, the former exhibit nothing of the kind. Surely selective metamorphism can do no more than this!

So far as our microscopic examinations have gone the iron ore exists in octahedral crystals when crystallized, whatever may be its present state of oxidation. Also it is difficult to find in our collection any specimens free from magnetic properties. It is to be remembered that Messrs. Brooks and Credner held that the ore was all originally magnetite, and that it in part had been subsequently changed to hematite. The microscope would seem to sustain their conclusion. It is to be remarked that the present magnetic state of the ore appears, in some cases at least, to be directly dependent on the presence of later eruptive rocks. We found that at or near the contact of the ore with such rocks, it (the ore) was strongly magnetic, but at a distance only slightly so. If the ore was originally all magnetite, it certainly was in the same condition in which it abundantly occurs in various eruptive rocks; if originally hematite, it was in the same state as it exists in less amount in some eruptive rocks, particularly acidic ones. So far as chemical objections exist to the presence of magnetite and hematite with siliceous minerals, we can simply say that no eruptive rocks exist but the same objections lie against them. Since all lithologists are aware that magnetite and hematite occur in modern lavas, it seems probable that the difficulty rests with the present knowledge of the chemists and not with the lavas.

We rest our conclusion that the jaspilite and iron ore in the Marquette district are eruptive upon the fact that they possess characters which eruptive rocks exhibit, especially in relation to other rocks, and which no sedimentary rock, proved to be such, has been known to have. They offer no characters inconsistent with those that known eruptive rocks have, but they do exhibit those, as said before, that no stratified rock has, so far as our present knowledge, not theory, goes.

It is not to be overlooked that the bog theory of their origin demands the following hypothesis, if we adopt the prevailing views. The rocks on which this material was deposited, must have been at that time metamorphosed or indurated to some extent. Hence they must have been originally depressed under the slowly accumulating weight of sediments down to the zone of aqueo-igneous fusion or near it. They must then have been as slowly elevated, denudation removing the superincumbent material. When restored to their original level or near it, the limonite was slowly deposited on their upturned and crumpled edges. Again the sediments accumulated and gradually these rocks with the limonite sank down to the zone of aqueo-igneous fusion or solution, the former passing through it. This selective zone picked out the limonite and siliceous mud associated with it, producing upon them all the marks of plastic eruptive material, which was squeezed in and through the overlying and underlying rocks, the latter remaining unaffected. Denudation again resumed its sway, and slowly and silently these rocks, buried four, five, ten, twenty or thirty miles beneath the surface, again appeared. These likewise are denuded and have deposited over them a conglomerate composed of their metamorphosed debris. Again down they went to or near the same zone when another elevation took place, and the Potsdam sandstone was deposited. We should then have three distinct ages in the "Huronian," all separated by vast intervals of time, instead of one period. Let us then imagine what this sedimentary theory demands in time and realize that this depression and elevation takes place through the influence of slowly deposited sediment on an earth "more rigid than glass and only less rigid than steel." Imagine the power required to elevate this vast area, the cubic miles of sediment to be deposited, and rock to be removed three times over.

On the other side the eruptive origin requires simply that the schists and sandstones should be deposited as usual, and the jaspilite and ore erupted as overflows and intrusive masses. No metamorphism is required or distinct age demanded, for as soon as cooled the rock would have nearly its present condition, and if poured out upon a sea shore would, as soon as solidified, be acted upon by the waves, forming the observed conglomerates.

We are perfectly willing to leave it to geologists to decide which is the simpler hypothesis and which demands least expenditure of time and energy. It is, however, not a question of simplicity, but a question of observed facts and evidence. We are perfectly willing to accept any theory that will explain the facts observed, but in the present state of knowledge we know of no view except the eruptive one that will explain the things seen by us, and we believe that the eruptive origin will explain every fact pointed out by those holding the view that the ore is sedimentary. We believe that the facts observed in studying the region under discussion, in a different manner from that employed by other observers there, sustain the views of Messrs. Foster and Whitney rather than those of more recent investigators.

It is not to be lost sight of, that as it was once fashionable to decide that rocks were eruptive, without evidence; so now it is likewise fashionable to decide that rocks are sedimentary, with like want of proof. As once any statement regarding the eruptive origin of any rock passed unquestioned, so now the similar wild statements about sedimentation pass unchallenged. The reasons for the position taken are rarely asked so long as the popular belief runs in the same direction. The day seems not so far distant as might be supposed, when it will again be as necessary to challenge the statements of those holding plutonic views as it is now those holding neptunian ones. The popular belief in any subject continually oscillates between different opinions like a mighty pendulum, passing and repassing the point of truth. But, strange fatality, if it stops at this point, all is stopped, the works are dead. When truth is reached or discussion ends, stagnation ensues. Again, when the pendulum vibrates, woe be to the man who swings not with it. In all candor we ask geologists to stop and think if the pendulum has not swung decidedly out of the perpendicular on the sedimentary side? Ease up a little, brethren, but do not swing back too far.

Besides the eruptive bosses, sheets, dikes, and wedge-shaped masses occurring both as overflows and intrusions, in the Marquette district, sedimentary deposits exist, as well as others formed from the decomposition of the ore and jaspilite *in situ.* For a description of these, figures of observed occurrences a fuller discussion of the subjects touched upon here, and many others, an historical account and general bibliography of both this and the Keweenaw Point district and a microscopic study of the rocks, the reader is referred to the Bulletin of the Museum of Comparative Zoölogy.

Dr. Wadsworth's paper was discussed by Prof. R. H. Richards, Mr. W. O. Crosby, and President Bouvé.

General Meeting. April 7, 1880.

Vice-President, Mr. S. H. Scudder, called the meeting to order. Twenty-seven persons present.

Mr. Scudder read a paper on the Devonian Insects of New Brunswick and their relation to the Doctrine of Descent.[1]

The following paper was also read: —

ON THE AGE AND SUCCESSION OF THE CRYSTALLINE FORMATIONS OF GUIANA AND BRAZIL. BY W. O. CROSBY.

INTRODUCTION.

The last quarter of a century has witnessed great progress in our knowledge of the stratified crystalline or eozoic formations; and nowhere is this advance more evident than in eastern North America. The stratified crystalline rocks of this part of the globe are no longer generally regarded merely as metamorphosed equivalents of the various Paleozoic terranes, but the portion so disposed of at the present time is comparatively small and yearly diminishing; and, with the exception of some limestones, nearly all crystalline sediments are now set down by a large number of the best geologists as unquestionably Eozoic. Nor, on the other hand, are these confessedly ancient sediments now habitually classed under the single designation of "primitive" or "crystalline," viewed as possibly largely of igneous origin, and referred to one grand epoch of past time. On the contrary, while their aqueous or sedimentary origin stands almost unquestioned, it is generally conceded that they are susceptible of chronological division equally with more recent formations; these divisions, in the almost complete absence of paleontological data, being based upon mineralogical, lithological, and stratigraphical characteristics. It is not my purpose here to discuss the much debated question of the adequacy of this class of data for the purpose named; but I may remark in passing that, in the opinion of a large and increasing number of geologists, experience has justified its use. Mistakes have been and are likely to be made, and yet that substantial and enduring results have been reached few will deny.

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[1] Published in the Anniversary Memoirs of the Society.

Stated in their most probable order of sequence, the divisions which have been established among the Eozoic rocks of eastern North America, chiefly through the labors of the Geological Survey of Canada, and especially of Dr. T. Sterry Hunt, are the following: Laurentian, Norian, Huronian, Montalban and Taconian. Of these divisions, the two first proposed — Laurentian and Huronian — are now almost universally accepted, and may be found in nearly all the modern manuals and text books of geology. Among the series outlined more recently, the Norian, on account of its lithological simplicity, is, perhaps, the most easily recognized and the most generally adopted; though it should be stated that some geologists of large experience with the rocks of this group regard them as belonging mainly if not entirely to the eruptive series, and therefore as insusceptible of chronological classification in the same sense as the rocks of the sedimentary series. The Montalban or White Mountain series exceeds all the other crystalline formations in its lithological and mineralogical diversity. It is the predominant crystalline series of the Appalachian region at nearly all points from Newfoundland to Georgia, and is now accepted as a distinct formation by many geologists.

The Taconian system attracts considerable attention at the present time; but, although the weight of opinion appears to be against this much disputed series, I am strongly convinced that it is a verity. Certainly those who admit the Eozoic age of the distinctly crystalline gneisses and schists cannot consistently doubt the existence of sediments intermediate in character and position between these and the uncrystalline Paleozoic beds. The essentially uncrystalline condition of the lowest Paleozoic strata, even in regions of great disturbance, is well illustrated by the Acadian group of eastern Massachusetts. This group, which lies at the very base of the Paleozoic column, and beneath everything in the New York system, includes, in ascending order, the conglomerate and slate of the Boston basin; and probably these are among the most highly disturbed Paleozoic rocks on the continent — folds, faults, and igneous extrusions on a large scale having conspired to complicate their structure and alter their lithological aspect. And what is the result? Nowhere in the Boston basin do we find a vestige of indisputable evidence pointing to the conclusion that there are crystalline rocks of Paleozoic age in this part of New England. Every crystalline rock in this region is represented in the pebbles of the conglomerate, and this rock certainly underlies the slate. Only in a few limited localities, where the slate and conglomerate have been altered by contact with intrusives — as at Nantasket, Weymouth, Brighton, and Nahant,— is it possible to trace any lithological resemblance between these and any crystalline rocks; and in all such instances the cause and local nature of the alteration are clear beyond dispute; and, furthermore, the altered rocks bear no likeness to any crystallines in this region, save where arenaceous layers in the conglomerate have the hardness of quartzite (and induration is the simplest species of alteration), or slate and sandstone have the texture of amygdaloid. In this last case, however, there is really no resemblance; for the very large amygdules developed locally in the slate at Mill Cove, in Weymouth, and East Point, Nahant, are entirely unlike anything observed in the true amygdaloid of the Boston basin. In short, crystalline characters are, practically, entirely wanting in the Primordial beds of eastern Massachusetts, notwithstanding these have at many points suffered an extreme degree of disturbance.

Probably the best test of the naturalness of the Eozoic divisions is that afforded by their greater or less universality. If the lithological groups or facies corresponding to the names Laurentian, Huronian, etc., are found to be persistent over an entire continent or hemisphere, and to preserve everywhere the same stratigraphical relations, giving an invariable sequence, then these important geological inductions must be considered as resting on a broad and firm basis of facts.

Comparisons of the stratified crystallines of North America and Europe have been instituted at various times, chiefly by Dr. Hunt; and in not a few instances important correlations have been reached. In fact, the equivalence, in a general way, of a large proportion of the Eozoic rocks of the two continents may be considered as pretty definitely settled. Nearly, if not quite, all the North American divisions are recognized in Scandinavia; and there can be little doubt of the existence in central and southern Europe of more or less typical developments of the Laurentian, Huronian, Montalban, and Taconian; while in the British Isles the correspondence seems well nigh perfect, and we are able to find there nearly everything observed on this side of the Atlantic, from the lowest Laurentian to the base of the Cambrian.

Dr. Hunt's most recent and, in some respects, most important contribution to the literature of this subject, is a paper read before the American Association for the Advancement of Science in September last, and published in the current number (April, 1880) of the American Journal of Science. In this we have: 1. An introduction, in which are indicated the main points of difference between what may be styled the plutonic and metamorphic schools of geologists, concerning the origin of the stratified crystallines, with a concise statement of the creed of the new school, of which Dr. Hunt may be fairly called the founder. 2. A brief historical sketch of the progress of our knowledge of the crystallines of North America during the last sixty years, with some of the more important correlations of the rocks of this country with those of Europe. 3. An account of the recent investigations in this department of geology in Great Britain, including a statement of the author's latest views concerning the age of the pre-Cambrian rocks of that country, and a partial list of the publications relating to them, which must prove very useful to the student.

Although the comparisons so far made between this country and Europe have not been exhaustive, yet, in the writer's opinion, enough has been done to show that, considering their age and the distance which separates them, the older rocks of the two continents exhibit a wonderful parallelism and, to a large extent, may be synchronized.

Approaching now the proper subject of this paper, I may observe that, although my opportunities for study in South America have been very limited, yet I have had occasion during the last two years to familiarize myself with a large part of the geological literature of that continent. While studying the descriptions of Darwin, Schomburgk, Jannetaz, Liais, Hartt, Derby, Brown and others, I have been frequently impressed by the strong resemblance in composition and sequence which they revealed between the stratified crystalline formations of North and South America; and my present purpose is to indicate the correlations which these comparisons have suggested. Thus doing for the eastern half of South America, though of necessity much less satisfactorily, what Dr. Hunt and others have done for a large part of Europe, and showing, as I think, that our Eozoic divisions persist in latitude as well as in longitude.

The vast tract of more than half a million square miles lying between the Orinoco and the lower Amazonas, which is designated by the general name of Guiana and includes French, Dutch, British, Venezuelan and Brazilian Guiana, is mainly composed of crystalline rocks. The Orinoco marks with great exactness the northern and western borders of the crystallines for a distance of eight hundred miles; while on the south, according to Mr. Derby, they are limited by a line drawn from the mouth of the Amazonas, in latitude 1° N., to the confluence of the Rio Negro and Rio Branco, between 1° and 2° south latitude.

This is for the most yart a region of elevated and broken land, being in striking contrast topographically as well as geologically with the broad Tertiary and alluvial plains which bound it on the north, west, and south. To the northward, between the Orinoco and the littoral cordillera of the Spanish Main, lies the Tertiary basin of Venezuela, which extends with the same natural boundaries, but rapidly increasing breadth, first to the west and then to the south until it connects with the vast Tertiary plain of the Amazonas.

South of the Amazonas there exists a still larger crystalline area, forming the highlands of Brazil, and extending through more than thirty degrees of latitude and twenty-five degrees of longitude. This mountainous tract is also separated from the Andean region by a broad expanse of newer formations; these sweep from the Amazonas, west of the Madeira, to the mouth of the Rio de la Plata. The late Prof. Hartt has shown very clearly that these great crystalline areas of Guiana and Brazil were above the sea in the earliest Paleozoic times, forming the nuclei of the embryo continent; the subsequent development of the eastern half of South America, at least, consisting chiefly in the closing of the broad straits between these primitive masses, by the addition, in concentric zones, of the deposits of later ages.

With the exception of some outflows of trap and, usually, a slight inclination away from the crystalline heights, the uncrystalline formations have suffered but little disturbance or alteration, the eastern half of South America being, in this respect, in striking contrast with the same part of North America. In this part of the world no general geological revolution has supervened since the close of Eozoic time; and the Paleozoic and more recent sediments have retained in a large measure their original structural simplicity and unaltered condition, making it impossible to question the Eozoic age of the most at least of the crystalline rocks.

CRYSTALLINE FORMATIONS OF BRAZIL.

For the little that is definitely known concerning the crystallines of Brazil we are indebted mainly to the labors of the lamented Prof. Hartt and his co-workers of the Brazilian Geological Commission. These results, as recently summed up by Mr. O. A. Derby,[1] show that the older rocks of the empire may be "naturally divided into two very distinct series, of which one, the most ancient, consists of crystalline rocks, including gneiss, gneiss-granite, and syenite, and the other, more modern, of altered, but in general non-crystalline rocks, consisting of quartzites, metamorphic schists, and crystalline limestones."

So far as studied, these great divisions of the Brazilian Eozoic show widely dissimilar characteristics in all parts of the Empire. The gneisses in the older series are described as containing much red or flesh-colored feldspar, and as being often granitoid, or obscurely stratified, porphyritic and schistose. The syenites consist typically of flesh-colored feldspar and hornblende, with little or no quartz; and are probably both exotic and indigenous. Epidotic rocks are abundant in some parts. The crystalline series is also said to be accompanied by an abundance of exotic rocks, including porphyry (felsite), diorite, and basaltic varieties. Liais[2] is very confident that these various eruptive rocks, especially the granite and syenite, are, frequently at least, of metamorphic origin, arising among the stratified terranes as the result of excessive alteration of the latter; the gneiss and granite, for instance, being identical in age and origin as well as in composition, and differing only in the degrees of metamorphism which they have experienced. This series was referred to the Laurentian by Prof. Hartt; and this correlation was confirmed by Dr. Hunt, after an examination of the specimens collected by Prof. Hartt. Limestones are sparingly associated with the gneisses.[3] These are white, coarsely crystalline, and contain a small amount of green serpentine. Specimens of the serpentinic limestone have been submitted by Mr. Derby to Dr. J. W. Dawson,[1] and this high authority announces that they contain Eozoon and are of Laurentian age.

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[1] Proc. Am. Phil. Soc. 1879, pp. 155-178 and 251-258.

[2] Climats, Géologie, Faune et Géographie Botanique du Brésil par Emmanue Liais. Publié par ordre du Gouvernement Impérial du Brésil. Paris, 1872.

[3] American Journal of Science, XIX, 1880, pp. 324-327.

Although the reference of this older series of Brazil to the Laurention is undoubtedly correct in the main, yet it is likely that future investigation will require farther subdivision. For in the descriptions of Darwin and some other writers, and especially of Liais, there are many passages referring to micaceous gneisses and schists containing garnets and allied minerals, and otherwise indicating the existence among the older crystallines of Brazil and Uruguay of typical Montalban strata. In fact, any one familiar with the mineralogical characteristics of the Laurentian and Montalban systems will recognize that Mr. Derby himself has set forth this division very clearly in his last contribution to the subject,[2] where he says, "The succession of the Brazilian gneisses is, according to the observations of Pissis, Hartt, Liais, and myself, (1) porphyritic or granitic gneiss, with red feldspar ; (2) fine-grained gray gneiss (leptinite of Pissis and Liais), often garnetiferous and schistose; (3) fine-grained schistose gneiss, passing to mica schist, with subordinate beds of quartzite, and an abundance of mineral veins not found in the lower parts of the series. This last, the upper or metalliferous series of Pissis and Liais, prevails in the Mantiqueira Range, while the lower divisions predominate in the Serra do Mar and Parahyba Valley."

The line between divisions (1) and (2) corresponds to a marked contrast in mineral characters, and appears to separate the Laurentian below from the Montalban above ; and the division, as thus drawn, appears to be as valid geographically as mineralogically.

The extensive deposits of petrosilex (porphyry) and stratified hornblendic rocks (greenstones) noted by Darwin and others in southern Brazil may, with much probability, be taken to represent the Huronian system. On the Pacific slope of the Andes, from Patagonia to Peru, or farther north, the older formations show a similar three-fold division, the characteristics of the Laurentian, Huronian and Montalban systems being, apparently, strongly marked and easily traced.

The second great division of the Eozoic rocks of Brazil is undoubtedly newer than, and, in the opinion of Mr. Derby, reposes unconformably upon, the first or highly crystalline series. The principal rocks of the second series are the quartzites; these frequently pass into ordinary sandstone and include many varieties; that best known, however, is the flexible sandstone or itacolumite, which is commonly and, as it seems, correctly regarded as the source — "die Muttergesteine" — of the diamond. Interstratified with the quartzites, and ranking next to them in importance, are the rocks classed as hydromica or talcoid schists. These likewise present many phases, and, although genuine hydromica schist is undoubtedly the prevailing type, argillaceous, chloritic, hornblendic and other rocks appear to be included, as well as much true argillite. The schists are often ferruginous, and associated with these and the quartzites are heavy beds of crystalline limestone and bedded iron ores, the itabirite being an interesting form of the latter.

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[1] American Journal Science XIX, 1880, pp. 324–327. [2] Ibid.

Stratified felsites are also said to form a part of the second series; these are likewise often red and ferruginous; but they are, apparently, less widely distributed than the preceding, and are not intimately associated with the schists and limestone. The stratification of the felsites is unquestionable since they are interstratified with quartzites, and sometimes, according to Mr. Derby, "show lamination, wave and ripple marks as clearly as any modern sandstone."

In the Amazonian region, the rocks of the second series are most favorably exposed in the rapids of the Tocantins, Tapajos and Trombetas Rivers. On the Tocantins the strata are compact and granular quartzites, hydromica and other schists and crystalline limestones; while on the Tapajos and Trombetas the felsites predominate, the quartzite is compact (felsitic?) and the schists and limestones are entirely wanting. Prof. Hartt believed the beds on the Tocantins to be newer than those on the other streams named, and this opinion is shared by Mr. Derby. In other words, the upper member of the Eozoic is divided by these geologists into two parts, the first or oldest including the felsites and compact quartzites, and the second the itacolumites, schists and limestones. To my mind, however, one of two things seems probable; either the felsite group belongs to the older or crystalline series, in which case it may be correlated with the unquestionably ancient petrosilex (felsite) and associated rocks of southern Brazil, Uruguay and Chili, the true Huronian; or else the so-called felsites are merely re-composed rocks, owing their Huronian characteristics to derivation alone. The relations of this group to the Tocantins series favor the former view, and the distinctness of the stratification in the felsites the latter.

Mr. Derby calls the felsitic group Huronian, evidently believing that the felsites are original; and he says that on the Trombetas River it is overlaid unconformably by sandstones containing Upper Silurian fossils. Lower Silurian (Cambrian) rocks have never been certainly identified in Brazil; but the Tocantins or itacolumite series was assigned to this chronological position by Prof. Hartt; and Mr. Derby, having shown by elimination that it is below the Upper Silurian and above the Huronian, concurs in the same conclusion. The semi-crystalline character of this itacolumite or hydromica schist series, the complete absence in it of organic remains, and the fact that its stratigraphical no less than its lithological features connect it much more closely with the underlying felsites and gneisses than with the Upper Silurian or any part of the Paleozoic system, so far as known, render it extremely improbable that this conclusion will be sustained by future investigation. And, furthermore, in my opinion, Mr. Derby's reasoning is defective, inasmuch as the existence of extensive systems of stratified rocks between the Huronian and the base of the Cambrian is now generally recognized; these intervening terranes being, of course, those bearing the names Montalban and Taconian.

The lithological and stratigraphical resemblance between the itacolumite, schist and limestone series of Brazil and the Taconian system of Eastern North America, including as typical examples of the latter the quartzite, saccharoidal limestone and hydromica schist of Berkshire County, Massachusetts, and the flexible sandstones and associated schists and limestones of the Carolinas, is so striking that it must be generally admitted; and I need not enter here into any detailed comparisons to enforce this point; the more especially since I have been anticipated in this correlation by so high an authority as Dr. Hunt. Neither their composition, structure, nor, so far as known, their relations to the subjacent and superjacent formations afford any reasonable ground for questioning the chronological equivalence of these two great series of rocks; and in both continents geologists are generally agreed that they lie along the border line between the Eozoic and Paleozoic, opinion differing mainly on the question as to whether they form the top of the former or the base of the latter. Although, as the preceding shows, I am not unmindful that the pre-Cambrian age of the Taconian system is disputed by many geologists, yet there are several points in the geology of South America having an important bearing on this question to which I desire to direct attention.

Rocks similar to the itacolumite, schist, and limestone series are known to occur in South America beyond the limits of Brazil. They constitute the main mass of the great eastern branch of the Andes, or at least of that part of it which skirts the Caribbean Sea from Caraccas eastward, and is known as the littoral cordillera of Venezuela. The cordillera forms the Northern Mountains of Trinidad, which have an altitude of three thousand feet, and terminates on the neighboring island of Tobago. These semi-crystalline rocks of the Spanish Main and Trinidad were studied some twenty years since by Messrs. Wall and Sawkins, by whom they were designated the Caribbean group, more recently by Mr. R. J. Lechmere Guppy, and in 1878 by the present writer.

The structure of the Northern Mountains of Trinidad is monoclinal, high southerly dips being the universal rule. The thickness of strata exposed is not less than ten thousand feet, and it may greatly exceed that estimate. The Caribbean group here includes three divisions, which, beginning with the oldest, present the following general lithological characters : —

1. Quartzite, in heavy beds, fine grained, and usually more or less micaceous.

   Hydromica schist, which shows frequent passages into quartzite and argillite.

   The argillite is abundant, and is often black, carbonaceous and lustrous.

2. Crystalline limestone, in massive beds, having in the aggregate a great thickness (several thousand feet), varying in color from white to nearly black, sometimes decidedly ferruginous, and often with scattered spangles of silvery-white mica. This calcareous or middle division is the highest, in a topographical sense, forming the crest of the mountains at most points.

3. Frequent alternations of the following rocks : —

   Argillites similar to those in the first division, frequently graphitic, and often passing into hydromica schist, which is less distinctly micaceous than below the limestone.

   Hard sandstone, sometimes approaching quartzite, and occasionally decidedly ferruginous.

   Conglomerate, with pebbles of quartzite apparently derived from the first division. The conglomerate is not abundant.

   Thin beds of calcareous matter toward the top.

The Caribbean group presents many points of resemblance, both lithological and structural, to the Taconian system of eastern North America, with which I have elsewhere[1] connected it. A correlation which appears to be justified, also, by its relations to the lowest Paleozoic formations. For we find that the third and highest division of the Caribbean group of Trinidad is overlaid on the south, with every appearance of unconformability, by the compact limestone which forms the Laventille Hills in the vicinity of Port of Spain and the small islands to the westward. This is entirely distinct from the crystalline limestone forming the middle division of the Caribbean group, and undoubtedly belongs to a more recent epoch than any of the rocks to the northward; and hence Mr. Guppy is right in urging that it should no longer be included in the Caribbean group. The compact limestone is rich in organic remains; but these are so obscure that it is only within the last decade that the fact of their existence has been certainly recognized. We are indebted to Mr. Guppy almost solely for the little that is known of the paleontology of this rock. The fossils so far made out are small bivalves resembling Nucula, and small univalves like Murchisonia and Loxonema. Besides these, there are, according to Mr. Guppy, a massive reef-coral and many serpuline fossils. Although Mr. Guppy is inclined to hold a different view, I am strongly convinced that the fossils which I have seen from this limestone have a decidedly Cambrian (Lower Silurian) aspect. Mr. Guppy has provisionally identified two of the Gasteropods with the North American species, *Murchisonia anna* Billings and *Murchisonia linearis* Billings, both Cambrian species. The limestone itself is very compact and massive, of a dark bluish-drab to black color, and presents a strong resemblance to the Trenton limestone of New York. Interstratified with it are occasional beds, one to twenty feet thick, of soft, thin bedded slates and shales, which are frequently highly ferruginous and have polished and glistening surfaces. It is chiefly by means of these argillaceous beds that we are able to observe the dip of the limestone.

Although, in the absence of fossils, and considering that an ocean lies between, the correlation of the Taconian system of North America with the itacolumite, schist, and limestone series of Brazil on the one hand, and with the Caribbean group of Trinidad and the Spanish Main on the other, may not be regarded as entirely satisfactory;

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[1] Proc. Bost. Soc. Nat. Hist., xx., 1878, p. 55.

yet I judge that no doubt can rest upon the conclusion that these two South American terranes must be essentially identical. But the Caribbean group is vastly older than the overlying fossiliferous and uncrystalline limestone, and hence almost certainly pre-Paleozoic.

Therefore, besides the fact that the Brazilian rocks are largely crystalline, and, in consequence, presumably Eozoic, we have two distinct lines of evidence pointing to the same conclusion; viz., their almost perfect resemblance, first, to the Taconian system, and second to the Caribbean group; and of the Eozoic age of the last named formation, at least, I think there can be but little doubt. In other words, the facts now known justify the prediction that, if rocks holding Cambrian fossils are ever discovered in Brazil, they will be found, like the Silurian beds of that country, and like the "compact limestone" of Trinidad (which is probably Cambrian), to lie unconformably above the great semi-crystalline series which includes the quartzite, hydromica schist, and saccharoidal limestone.

This division of my subject may be summed up as follows: —

We recognize among the crystalline rocks of Brazil, or rather, of that part of South America south of the Amazonas, not less than four distinct and mutually exclusive series, which present a fair agreement lithologically and, so far as the evidence allows us to judge, in their order of succession or stratigraphically, with the Laurentian, Huronian, Montalban and Taconian systems. The oldest and newest of these four series, or those which we may designate, provisionally at least, as the Laurentian and Taconian, predominate in Brazil; while on the western slope of the Andes the Huronian and Montalban beds are more characteristic.

CRYSTALLINE FORMATIONS OF GUIANA.

Passing now north of the Amazonas to the crystalline tract of Guiana, we find that the geological literature is even more meagre here than south of the great river. The geological observations of Humboldt and the later descriptions of Sir Robert Schomburgk are too general, too little discriminating lithologically, to be of much value here.

The greater part of this vast area is a wilderness into which the white man rarely penetrates; and, so far as I am aware, only two limited tracts have been studied geologically in anything like a systematic manner. These are British Guiana, and that part of Venezuela known as the Caratal Gold-field, with the district one hundred miles broad lying between it and the Orinoco.

During the years 1867–73 a geological survey of British Guiana was carried on, under the authority of the British Government, by C. Barrington Brown and J. G. Sawkins, both men of large experience in the geology of the northern part of South America and the West Indies. The scientific results of their explorations, including a geological map of the Colony, were published in 1875.

Although this report represents several years of hard work, yet the difficulties encountered were so great that we have here, so far as it relates to the geology, at least, little more than a sketch. All the impediments to exploration naturally pertaining to a wilderness under the equator had to be surmounted, including the almost impenetrable tropical forests which made the rivers, with their numerous rapids and cataracts, with slight exceptions, the only practicable routes of travel, and including also the absence of even approximately correct maps of the territory.

There is, however, a grand simplicity in the geology of this region which gives a mere outline sketch much greater value than it would otherwise possess; and, although so much remains to be done, yet the main geological features of the Colony appear to be pretty well made out. The line between the crystalline and the uncrystalline formations is strongly marked and unmistakable, the contrast being even greater here than in Brazil.

The coast is fringed at all points by a belt ten to seventy miles broad of Post-tertiary sands and clays. This follows the valleys of the principal streams long distances into the interior, and is the only fossiliferous formation in the Colony. Covering an area of about 10,000 square miles in the western central portion of the Colony, and forming the main mass of the Pacaraima Mountains, is a great sandstone formation. "It is composed of interstratified beds of coarse conglomerate, red and white sandstone, and red shale. Interbedded with the sandstone are three great layers of "greenstone," partly contemporaneous and partly intrusive. This greenstone is a coarse variety of diorite (or diabase), composed of hornblende (or augite) and feldspar. The total thickness of the sandstone formation, including the green-stone, is about 7,000 feet; the three greenstone layers varying in thickness, in different localities, from 400 to 1,000 feet each. The sandstone, as a whole, lies in a nearly horizontal position, dipping northwardly with but few local disturbances, and, so far as could be seen, it is singularly free from faults and dislocations." It is observed to rest with perfect unconformability upon the underlying crystalline formations, of the ruins of which it is composed. The sandstone forms the highest land in the Colony, including the remarkable vertical-walled table-mountain of Roraima.

Roraima reaches an altitude of 7,500 feet, the last 2,000 feet being perpendicular; and Mr. Brown claims that whatever animals may inhabit the summits of this and adjacent mountains of similar formation must have been cut off from communication with the surrounding country since a very early period, and therefore he finds it interesting to speculate upon the strange forms which the "survival of the fittest" may have developed there.

Concerning the age of this formation, Mr. Brown says, — "The absence of fossils in the sandstone is very singular, and prevents one from arriving at the epoch of its deposition. It appears to me, however, to be an equivalent of the new red (Triassic) sandstone." This, it may be remarked, is the age which Mr. Derby assigns provisionally to the precisely similar sandstone and trap formation of southern Brazil.

With the exceptions named, all the rocks of British Guiana are crystallines; and these are arranged by Brown and Sawkins in three general groups which, beginning with the oldest, are designated as follows: — 1. Granite and syenite; 3. Quartz–porphyry and felstone; 3. Gneiss and schist. The first group is one of great importance, covering about one-third of the Colony. It consists mainly of granite, the syenite occupying a very subordinate position. The granite varies greatly in texture, but it is usually coarse and often porphyritic; the feldspar is commonly white, but sometimes red; and, as a rule, the rock is little micaceous. The granite lies at the base of all the rocks of the Colony, and coarse veins of it have pierced all the overlying formations, including even the sandstone in one place.

This rock is undoubtedly eruptive in the main, and yet, in the descriptions of Brown and Sawkins, there are plain indications that it is not wholly so. A gneissic structure and passages into distinct gneiss are mentioned as characterizing it at many points. What appears to be the same formation has a large development in French Guiana, being probably continuous through Surinam, and it is here referred by Edouard Jannetaz to the same age as the oldest gneisses of Brazil, which are Laurentian.

Next in chronological order comes the quartz-porphyry and felstone series. This occurs mainly in the central part of the Colony, covers an area of several thousand square miles, and rests at all points upon the granite. These rocks, which present many varieties in both texture and composition, are said to occur sometimes in the form of dykes; but, after a careful study of the descriptions and sections, I am strongly persuaded that they are chiefly indigenous. Many passages might be quoted in which the bedded nature of the porphyries is either asserted or distinctly implied, although Messrs. Brown and Sawkins, like most English geologists, belong to the plutonic school. Associated with this petrosiliceous group and forming a part of it are various hornblendic, slaty and other more nondescript rocks, all distinctly bedded. But, whatever the origin of the group, I think there can be but little doubt that it corresponds in age to the great petrosilex series of the Andes and southern Brazil and may be provisionally referred to the Huronian system.

The third crystalline group, composed of gneisses and schists, rests, in different places, upon both the preceding groups, and probably embraces the newest stratified crystallines in the Colony. The gneiss predominates and is described as sometimes granitic or syenitic, but it is usually highly micaceous and distinctly stratified or schistose. The bedding is often excessively contorted, and passages into true mica schist are common. The feldspar is white, and large crystals are sometimes porphyritically interspersed. Garnet is the principal accessory constituent, and veins of coarse granite holding tourmaline, garnet and other minerals are mentioned as frequently occurring.

The schists are still more various. Mica schist prevails, but chlorite and hornblende schists, steatite and quartzite are also included. Garnets are abundant in the mica schist, and the coarse endogenous granite is found equally in this rock and the gneiss.

The gneiss and schist series extends into French Guiana; and, according to Jannetaz, parts of the mica schist are rich in staurolite as well as garnet, while tourmaline, rutile and zircon also occur. The Montalban characteristics of this formation are very marked, and no argument is required to show that it agrees closely with the upper part of the older crystalline series of Brazil, which I have already referred to the Montalban series.

Jannetaz has pointed out the fact that there is a very exact correspondence between the crystallines of Brazil and French Guiana; and besides the points of resemblance already considered I may mention that he has recognized in the last named country the itacolumite, hydromica and other schists and itabarite constituting the metamorphic or newer crystalline series of the former, which has been connected with the Taconian system. The itacolumite of Guiana has also been observed by Schomburgk.

The limited district in Venezuela known as the Caratal Gold-field possesses considerable historical interest, since it was, doubtless, the fabled El Dorado of the 16th century. It is situated on the Yuruari River, the most northern affluent of the Essequibo, and about one hundred miles in a direct line south of the Orinoco. The principal papers which I have been able to find relating to the geology of this region, are those by R. P. Stevens,[1] C. LeNeve Foster,[2] Ralph Tate,[3] and George Atwood.[4] Besides these, I have the notes made by my father, F. W. Crosby, during his residence in that country from 1876 to 1878.

The general line of strike in all this part of Venezuela is east and west. The gold mines are reached by the road which runs south-easterly from Las Tablas on the Orinoco. This road affords a good transverse section of the formations; and, since it is much travelled, we find that the contributions to the geology of southern Venezuela usually consist chiefly of descriptions of the section from the Orinoco to the gold mines. At about one-third of its length from the Orinoco, this line of section crosses the Imataca range of mountains, which attains an altitude of about 3,000 feet and forms the water-shed between the Orinoco and the Essequibo.

The concurrent testimony of nearly every observer from the time of Humboldt to the present day is in favor of the view that this section consists almost entirely of distinctly stratified crystalline rocks. LeNeve Foster begins his descriptions with the statement that "the country between Ciudad Bolivar (on the Orinoco) and Pastora (in the Caratal district) consists almost entirely of gneiss, with some mica-schist and hornblende schist, and a little granite; and Tate, referring to his published section, says it "will suffice to show the regularity of the bedding, and the somewhat undisturbed condition of this series."

[1] Proc. Phila. Acad. Nat. Sci., 1868, pp. 303-304; and Eng. and Min. Jour., 1869.

[2] Quart. Journ. Geol. Soc., London, xxv., 1869, pp. 336-343.

[3] Quart. Journ. Geol. Soc., London, xxv., 1869, pp. 343-350.

[4] Quart. Journ. Geol. Soc., London, xxxv, 1879, pp. 582-590.

Mr. Atwood, so far as I am aware, stands alone among the students of this section in regarding it as composed chiefly of eruptive rocks. The radical difference between Mr. Atwood's views and those of the other observers named is best shown by comparing the sections published by him and Mr. Tate. These two sections cover precisely the same ground, and yet, while Mr. Tate's section consists almost entirely, at least nineteen-twentieths, of stratified rocks, these are found by actual measurement to form only one-sixth of Mr. Atwood's section.

Mr. Atwood's lithological determinations are based chiefly upon notes (which are appended to his paper) of microscopical examinations of specimens by Prof. T. G. Bonney. But I venture to say that his data here are very insufficient. In the first place only nine specimens were examined, and four of these — two gneisses, one hornblende schist, and one quartzite — Prof. Bonney says are stratified. And of the remaining five specimens, only two — one basalt and one diabase, admitted to be eruptive by all observers — are set down positively as eruptives. Of the other three Prof. Bonney speaks rather vaguely as follows: — "No. 1. * * * * We may venture to say that the rock has once been a gabbro." "No. 7. * * * * The structure is rather abnormal; but I think it must be an igneous rock, and thus is a variety of quartz-diorite." "No. 8. * * * * The rock appears to be of igneous origin, and so is a microlinic syenite."

The lithological descriptions of LeNeve Foster, Tate, and Stevens are substantially the same; and from these we learn that between the Orinoco and Yuruari Rivers there is a great series of gneissoid rocks, with interstratified hornblendic and micaceous schists and quartzite. The gneisses predominate and are usually distinctly bedded and schistose, sometimes granitoid, micaceous as the rule, but hornblendic at several points, passing into diorite and syenite, in part highly garnetiferous, and enclosing, in the Imataca Mountains, heavy beds of specular and magnetic iron ores. All observers are agreed that the iron ores are interstratified deposits. Portions of the gneiss also hold an abundance of endogenous quartz, and it is probable that some of the granitoid varieties are true granite.

Comparison shows that this part of the section is essentially equivalent to the first and third divisions of Brown and Sawkins in British Guiana; while the east-west strike favors the view that the crystalline formations of that region are continued to the westward as far, at least, as Caratal and the Caroni River. And this conclusion is strengthened when we examine the southern end of the Orinoco and Caratal section, for the rocks south of the Yuruari River are, apparently, precisely the same as the quartz-porphyry and felstone series of Brown and Sawkins. They are usually described as compact, porphyritic, and banded felsites, distinctly bedded for the most part, and interstratified with talcose, hornblendic and other schists.

It is apparent, then, that the older crystalline rocks of the whole vast region of Guiana, so far as it has been explored, may be, and to a great extent have been, arranged in three series, which correspond closely with the three crystalline series believed to exist in the southern half of the continent, and which I have stated to possess in a large degree the essential characters of the Laurentian, Huronian, and Montalban systems. While unconformably overlying all of these, in both sections of the continent, are the itacolumites, semicrystalline schists and marbles, which, like the Taconian rocks of North America, represent a horizon near, but below, the boundary line between the Eozoic and Paleozoic.

General Meeting. April 21, 1880.

The President, Mr. T. T. Bouvé, in the chair. Thirty-five persons present.

The concluding pages of the preceding paper were read by Mr. Crosby.

Mr. Edward Burgess read a paper on the Anatomy of the Milk-weed Butterfly, (*Danais Archippus* Fabr.)[1]

Gen. F. A. Osborn, for the Committee on the nomination of Officers for 1880–81, presented a report.

Mr. Bouvé said that four years ago he had consented to withdraw his resignation as President, but he felt obliged for several reasons to decline re-election the present year, and begged that the Society would not ask him to reconsider his determination.

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[1] Published in the Fiftieth Anniversary Memoirs of the Society.

Mr. S. H. Scudder hoped that Mr. Bouve's withdrawal was not imperative, and spoke of the importance of the work done under his administration, which had resulted in the final crystallization of the Society's policy.

Remarks of the same tenor were also made by Prof. A. Hyatt, Mr. E. Burgess and Mr. Nathan Appleton.

Mr. Bouvé thanked the speakers, but reiterated his resolve to resign. The Nominating Committee was therefore instructed to withdraw and reconsider its report.

After a brief delay the Committee presented the following nominations, and was discharged: —

PRESIDENT,
SAMUEL H. SCUDDER.

VICE-PRESIDENTS,
JOHN CUMMINGS, F. W. PUTNAM.

CURATOR,
ALPHEUS HYATT.

HONORARY SECRETARY,
S. L. ABBOT, M.D.

SECRETARY,
EDWARD BURGESS.

TREASURER,
CHARLES W. SCUDDER.

LIBRARIAN,
EDWARD BURGESS.

COMMITTEES ON DEPARTMENTS.

Minerals.
Thomas T. Bouvé,
R. H. Richards,
M. E. Wadsworth.

Geology.
L. S. Burbank,
Wm. H. Niles,
Rev. G. Fred. Wright.

Palæontology.
Thos. T. Bouvé,
N. S. Shaler.

Radiates, Crustaceans and Worms.
H. A. Hagen, M.D.,
Alexander Agassiz,
L. F. de Pourtalès.

Mollusks.
Edward S. Morse,
J. Henry Blake.

Insects.
S. H. Scudder,
Edward Burgess,
A. S. Packard, Jr., M.D.

Botany.

JOHN CUMMINGS,
CHARLES J. SPRAGUE,
J. AMORY LOWELL.

Microscopy.

SAMUEL WELLS,
R. C. GREENLEAF,
B. JOY JEFFRIES, M.D.

Comparative Anatomy.

THOMAS DWIGHT, M.D.,
J. C. WHITE, M.D.,
W. F. WHITNEY, M.D.

Fishes and Reptiles.

F. W. PUTNAM,
THEODORE LYMAN,
S. W. GARMAN.

Birds.

J. A. ALLEN,
SAMUEL CABOT, M.D.

Mammals.

J. A. ALLEN,
E. L. MARK,
GEO. L. GOODALE, M.D.

Prof. Hyatt read a letter from the Boston Scientific Society, presenting models of the sun and earth in proportionate size for hanging in the arches of the entrance hall of the Museum. The gift was gratefully accepted, and a vote of thanks passed for the same.

FIFTIETH ANNIVERSARY OF THE SOCIETY'S FOUNDATION.

APRIL 28, 1880.

The Society celebrated its Fiftieth Anniversary by a special meeting in its Museum April 28, 1880. Addresses were made by President T. T. Bouvé, Governor John D. Long, Dr. Samuel Eliot, President Charles W. Eliot, Mr. Alexander Agassiz and Rev. R. C. Waterston. An account of the celebration and the addresses in full are given in the Anniversary Memoirs of the Boston Society of Natural History, published in celebration of the Fiftieth Anniversary of the Society's Foundation.

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ERRATA.

Page 193, 19th line from top for ninth read n^{th}

Page 194, 2nd equation from bottom for $=xb^{n-1}$ etc., read zb^{n-1}etc.

Page 263, for Rev. E. Wadsworth read Dr. etc.

Page 315, 4th line from bottom, for microscopic read macroscopic.

Page 402, substitute for the first two lines:

Female being unlike that of *Cerceris*, in the simple posterior tarsi of the male, and in the long bristles on the anterior tarsi of the female. Spinola describes a row of parallel spines on the anterior tarsi of *Nectanebus* in both sexes alike, but his figures in Guerin's *Magazin de Zoologie*, 1840, show these spines to be short as in *Cerceris*. Doubtless there will be found to be differences also in the dentition of the mouth parts when these characters are studied in *Nectanebus*.

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